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JULY, 1940

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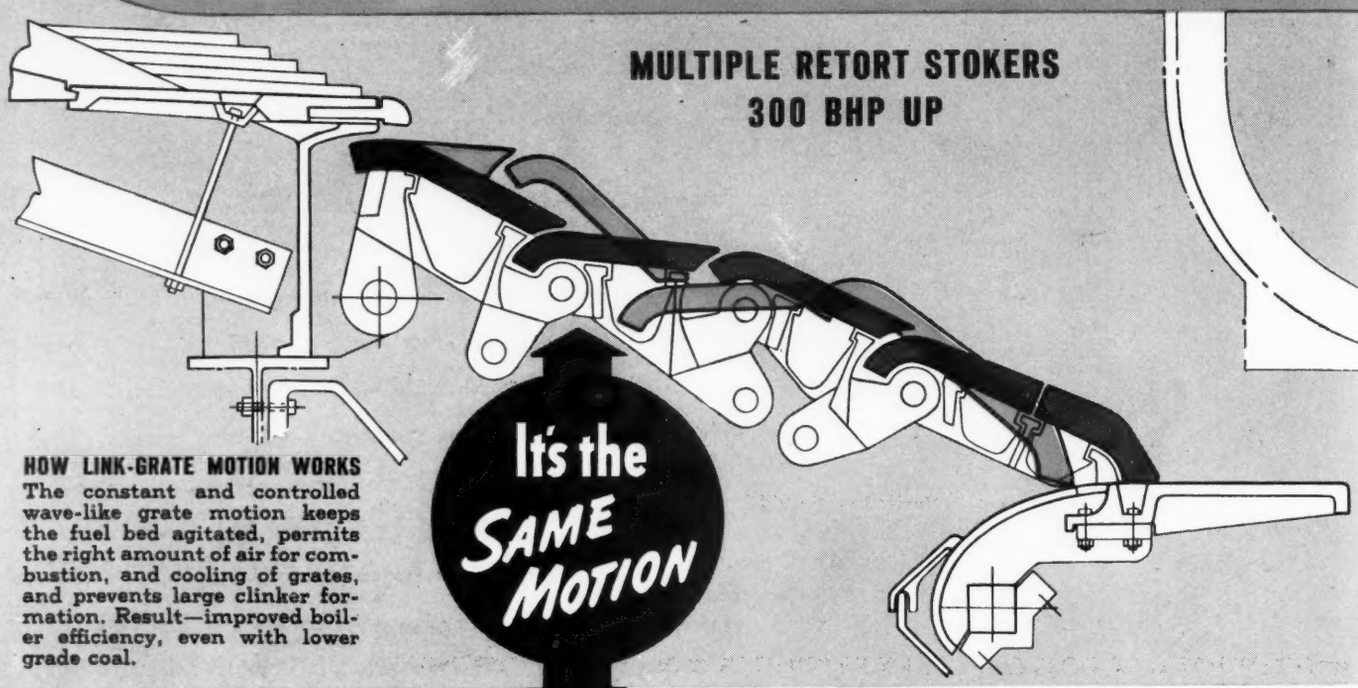

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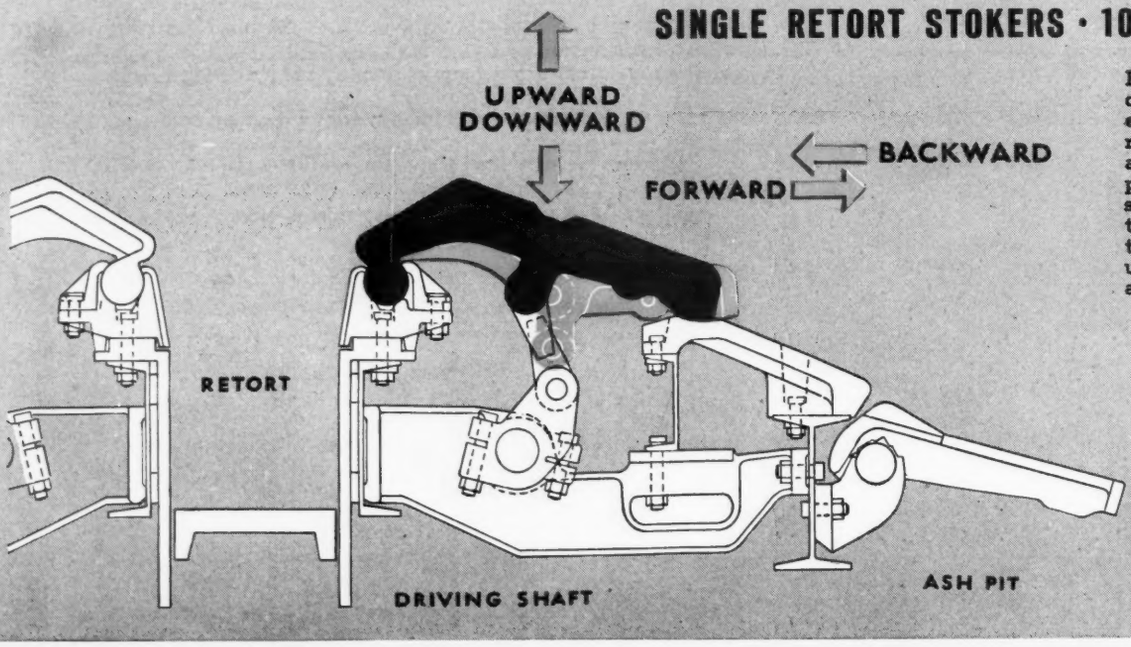

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37 Billion Btu per Pound

USING A QUANTITY far less than the head of a pin, the laboratory has proved that nature's heaviest metal, Uranium (in the "isotope" 235), can be made to release 37 billion Btu per pound in a self-propagating "chain" reaction. Thus one pound of Uranium 235 will *deliver* as much heat as 1370 tons of 13,500-Btu coal. From this amount of heat one could easily produce, by existing methods, 2,700,000 kilowatt-hours.

Many hundreds of tons of Uranium 235 are present in known pitchblende deposits, but the separation of this Uranium fraction is so difficult that it may be decades before commercial quantities can be obtained. The search for a practicable extraction technique will attract the best research minds of physics, chemistry and metallurgy, because Uranium 235 should be worth several thousand dollars a pound as a fuel for the atomic power plants of the future.

The scientific possibility of atomic-power generation has now been definitely established. Commercial realization must await first, the solution of the tremendously difficult problem of separating Uranium 235 in commercial quantities and at commercial cost, and then (less difficult, it seems) the development of equipment to turn this heat into steam at usable pressures and temperatures.

Prediction is always a dangerous sport, but it is our guess that atomic power will *eventually* become a commercial reality. It is also our guess that the widespread generation of power and process heat from atomic energy is still too far in the future to affect the useful life of conventional power plants being installed today.

If and when it becomes commercially feasible to use this atomic energy on a large scale, it seems, as we see it now, that the transformation of this heat into electricity might involve exactly the same power equipment as for coal, except for certain parts of the steam-generating equipment.

If and when atomic fuels become commercial, their applications might conceivably include central-station power generation, industrial power, process heat, house heating, automobile power, airplane power, locomotive power, ship power. The heat might be converted through "internal-combustion" engines as well as through steam plants.

Then, of course, there is the possibility of direct production of electricity from the exploding atoms, and of many specialized applications which we can no more imagine today than we could have pictured radio broadcasting in the gay nineties.

As we view it, atomic power is not a subject of immediate *practical* concern to the men who operate and design power plants. Most power engineers, however, like to dream of the distant future of their profession and its technique. To them this article will bring something to think about in off hours.

From the strictly practical angle, we hope the following pages will inspire some of the pioneering younger men to play a part in the experimentation and analysis that will mould the power plants of the future—to do, perhaps, what Faraday in 1831 did for the Pearl Street generating station of 1882.—PWS.

URANIUM 235—POWER FUEL OF

Under proper control, one pound of Uranium 235 will "burn", and deliver 37 billion Btu, as much as 1370 tons of good coal. Hundreds of tons of 235 exist in known pitchblende deposits, but commercial separation presents stupendous difficulties, so early practical application seems unlikely. Here are the known facts, leading to the conclusion that atomic power plants are a future probability

By PHILIP W SWAIN, Editor

▶ URANIUM, heaviest of all metals, has three forms (chemists call them "isotopes") more alike than human triplets. In most chemical and physical respects they are practically identical. These isotopes are called Uranium 234, Uranium 235 and Uranium 238, the numbers being the respective atomic weights.

In one respect only, as far as we know now, does 235 stand out from its brothers as the Empire State Building towers above a one-story "tax payer." It has been proved by actual laboratory tests made this year on a little sliver of Uranium 235 (in the whole world a mere fraction of a pinhead of this material has so far been isolated for experimental purposes) that a relatively slow atomic projectile impinging on the nucleus of an atom of 235 will explode it, breaking the "massive" atom up into two atoms of substances about half as heavy.

Atomic Explosions

More important, it has been proved that the fragments of this explosion have far greater energy than that of the original projectile, so that the energy released is practically all net gain. These moving fragments of a terrific atomic explosion are easily brought to rest by barriers of matter, thereby heating the barriers and delivering their energy as ordinary sensible heat, just as burning coal does.

At this point, the physicist would explain that the atomic energy so released is actually a conversion of mass into energy. About 0.1% of the mass of the Uranium atom is lost in being transformed.

If every atom in one pound of 235 were thus exploded, the heat delivered for outside use would be 37,000,000,000 Btu per pound. Uranium 235, as a fuel, is equivalent to 1370 tons of 13,500-Btu coal. Directly or indirectly, this heat could make steam. This steam, with present-day turbine-room equipment, could easily be converted into 2,700,000 kwhr of electrical energy, assuming the very conservative conversion efficiency of 25%. This would be enough to operate a 100-hp motor continuously at full load for 3 years.

Naturally, then, this discovery will interest the wide-awake power engineer. If he is wise, however, he will not rush off to buy any stock in Uranium power plants until he has sized up some of the difficulties that must be overcome before this splendid bird in the bush can become a chicken in the pot.

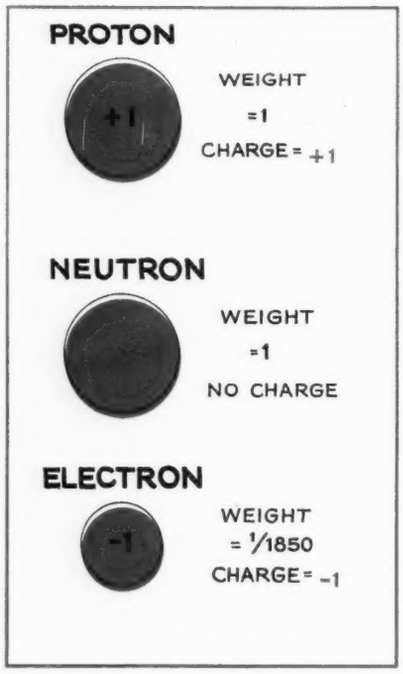


Fig. 1—The building blocks of matter

Hard to Separate 235

First is the still unsolved and extremely difficult problem of commercially separating Uranium 235 from the parasitic 234 and 238 with which it is always mixed in a state of nature. Every pound of Uranium 235 recovered from natural ores is intimately mixed with about 140 lb of 238 and about 1/120 lb of 234. Commercial Uranium metal always runs about 0.006% of 234, 0.7% of 235 and over 99% of 238. Getting rid of the 238 is the practical problem.

Assuming that several pounds of 235 could be obtained at reasonable cost (it would be cheap at several thousand dollars per pound), there would still be numerous engineering problems to be solved in transferring the released heat to steam or some other working medium. These problems, nevertheless, seem less difficult than that of obtaining the 235.

Let's Look at Some Atoms

With this preamble, it seems worth while to review, in ABC fashion, just enough atomic physics to give the reader a mental picture of how 235 works. Most power engineers have not been following this line. The explanations will cut a lot of corners, and may not be completely satisfactory to physicists, but will suffice for present purposes.

Fig. 1 diagrams the more important basic building blocks of matter—of *all* matter from molasses candy to arsenic, from gold to cast iron. These "blocks" are proton, neutron and electron. Proton and neutron are alike in mass ("weight"), but differ electrically. Proton and electron differ enormously in mass, but have equal and opposite electrical charges. Lets call the mass of the proton 1 and its electrical charge +1. Then the mass of the neutron is 1 and its charge zero. The mass of the electron is insignificant (1/1850), but its charge is −1.

To keep the record straight, we should note the occasional appearance

THE FUTURE?

of positively charged electrons, called "positrons," and the possibility that there is a tiny neutral particle, the "neutrino." Forget these; they do not concern the present discussion.

The Hydrogen Atom

Fig. 2 shows the simplest and lightest of all atoms, that of hydrogen. Here we have a "solar system" consisting of one "sun," a single proton with a plus charge, around which revolves at inconceivable velocity one "planet," a single electron with a negative charge. Plus and minus attract, so the electron tries to fall into the proton, just as the earth tries to fall into the sun because of the gravitational pull. But both moving earth and moving electron tend also to move in a straight line (tangentially). The tangential tendency and the centripetal pull balance in the compromise of circular or elliptical motion.

Since the weight of the electron is negligible, the weight of this hydrogen atom is simply the weight of its proton, "1," the figure given in all chemistry books for the approximate atomic weight of hydrogen. (The number of hydrogen atoms in a pound can be expressed as "1," followed by 27 ciphers, thus, 1,000,000,000,000,000,000,000,000,000.)

Please note that Fig. 2 is not "to scale"—not by a long shot. Diameter of the hydrogen atom is about 1/100,000,000 of an inch. Even at that, the atom's diameter is about 100,000 times that of the electron and also 100,000 times that of the nucleus.

In the case of this ultra-simple hydrogen atom, the center, or "nucleus," consists of but one particle, a proton. All other elements are heavier than hydrogen, and have more than one proton in the nucleus. To balance these positively charged protons, they must have an equal number of negatively charged electrons in the outer orbits. Thus, in the atom of *any* element, there will be as many electrons whirling around in various outer orbits as there are protons bunched in the nucleus. Nobody knows exactly what goes on in the nucleus, but the protons (when more than one is present) must be moving with extreme velocity.

In addition to these protons, the nucleus of the typical atom (not hydrogen) contains some neutrons. These add to the mass, though electrically neutral. To a fair degree of accuracy, the atomic weight of any substance is simply the numerical sum of the protons and neutrons in the nucleus of its atom.

It may be asked how the protons can possibly bunch together in the nucleus (since their positive charges must repel), or even how the neutrons can remain in the nucleus (since they, too, are moving and should thus tend to fly out). The physicist's answer to this

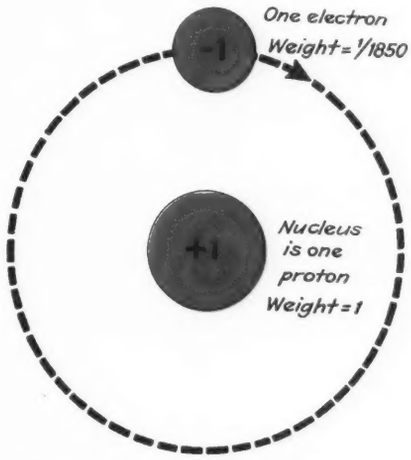


Fig. 2—Hydrogen atom is the simplest and lightest. One electron (weight 1/1850) revolves around a nuclues of one proton (weight 1)

is a mysterious attractive force of one mass for another which becomes very powerful at these minute distances, but fades into significance if the distance approaches the diameter of one atom.

The Uranium Atom

Fig. 3, picturing the atom of Uranium 235, is even more schematic than Fig. 2. It must not be taken too literally except as to counts, charges and weights. The electrons, for example, are probably moving in orbits tilted at all angles to the paper and a great variety of radii. They don't swirl around in unison like a line of horses in a circus ring. No attempt has been made to picture the true arrangement, but the numbers indicated are correct and exact.

The 92 moving electrons in the various outer orbits of this atom contain a lot of energy, but it is small compared with the total in the swarming 92 protons and 143 neutrons of the nucleus. Each of the 235 particles in the nucleus weighs 1850 times as much as one electron.

The energy of matter may be considered from the angle of the energy *in* the matter or of the energy one can *get out*. From the first point of view all forms of matter are approximately equal, having an internal atomic energy of about 40 trillion Btu per pound.

To release some of this energy, the atom has to be broken up, or break up of its own accord. Radium is the classic example of the latter. It disintegrates slowly, giving off energy steadily. In 1600 years its radiation shrinks to half value.

Bombarding Atoms

Other atoms have been broken up by bombardment with fine particles—usually high-speed protons or neutrons, traveling 10,000 miles per second, or faster. The resulting explosion may give off energy (sometimes more, sometimes less, than that of the original projectile), but the number of direct hits on the tiny nucleus is so small, and the cost of generating the projectile is so large, that it's "no sale" as far as power generation is concerned. But Uranium 235 is different.

Suppose you use a "very slow" neutron projectile, one moving no faster than a molecule of air in a room at 70 F (about 1000 ft per second). If this projectile happens to hit the nucleus of an atom of Uranium 235 it will split the atom up into two atoms of new substances of about half the original atomic weight. These two fragments fly apart with catastrophic violence. "Spare parts," in the form of 2, 3 or 4 neutrons (average about 3) will be left over from the atomic split and will fly out freely with enormous velocity. The energy in these exploding fragments will be several billion times that of the projectile used—as if a ton of dynamite were set off by one small detonator.

One interesting thing about 235 is that it is broken up much easier by a slow projectile than a fast one. There appear to be two reasons for this. First, the Uranium 235 nucleus is so unstable that a "soft" blow will smash it as surely as a hard one. Second, a "slow ball" is much more likely to make a hit.

Actually the nucleus is much smaller in proportion to the size of the atom than shown in the Fig. 3. The chance of a given neutron being aimed straight

at this bull's eye is very small. One must generally count on the projectile being "sucked in" as it passes. As already noted, the protons and neutrons in the nucleus are drawn together by some powerful dominating force when they get close enough. This same force will act on a passing neutron projectile. A fast shot will be deflected little, and will probably miss, as shown at the top. The "slow ball," shown lower down, will probably be sucked in to land a hit, if its original line of motion is reasonably close to the nucleus.

Whatever the explanation, it is certain that a stream of high-speed neutrons breaks up very few atoms of Uranium 235, whereas a stream of slow-speed neutrons is very effective.

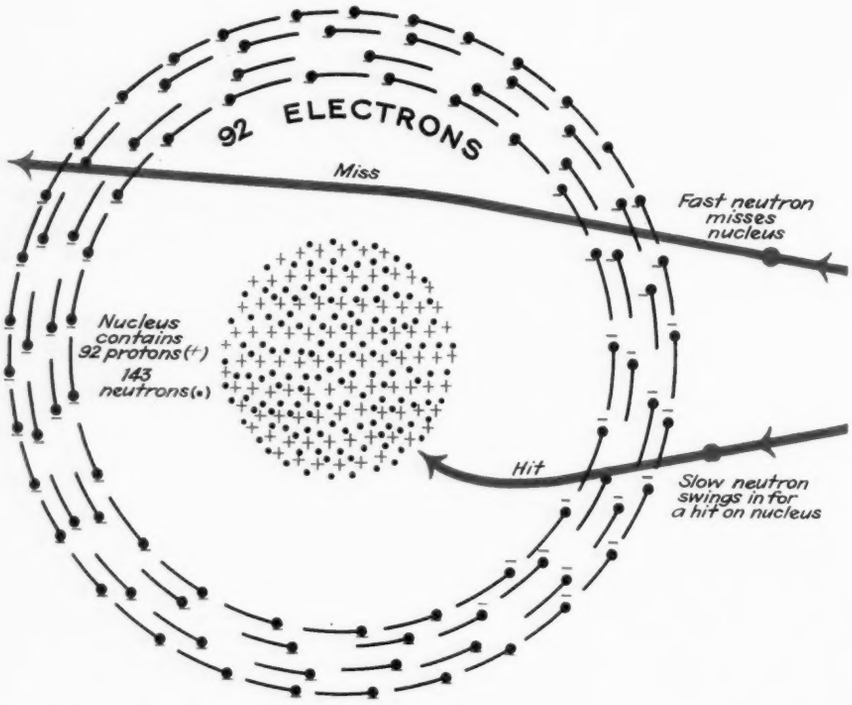

92 ELECTRONS
Miss
Fast neutron misses nucleus
Nucleus contains 92 protons (+) 143 neutrons (•)
Hit
Slow neutron swings in for a hit on nucleus

Fig. 3—Atom of Uranium 235 contains 92 protons (+) in nucleus, electrically balancing 92 electrons (—) in outer orbits. Since electron weight is negligible, atomic weight = 92 + 143 = 235. Sketch is purely schematic

Search for a "Chain"

The idea of atomic power calls for a "chain" reaction. We find this often in nature. You light one leaf with a match and the whole pile becomes a bonfire. The same thing happens with a gas flame or with coal on a grate. You disturb one boulder on a steep mountain and thereby start an avalanche. All these are chain reactions. Junior sets up a row of dominos on end, trips the first and all fall down. Another chain reaction.

Applying this process to a mass of Uranium 235, you would explode the first atom with a neutron projectile fired from the outside. You might expect neutron fragments from the first explosion to explode several additional atoms and so on. Thus the disintegration of atoms would continue of its own accord until the entire mass was converted into lighter elements and the whole available 37 billion Btu per pound released.

While physicists have been seeking something of this sort, some of us have wondered. Suppose the chain should work instantly! One pound of Uranium 235 would blow up the laboratory, the institution and probably the whole town. On the optimistic side was the thought that if this could happen nature would have accidentally touched off the combination long ago.

Chains so far obtained with Uranium 235 have not been self-perpetuating for two reasons. One is that the experimental work was conducted with a thin film of 235. Practically all the neutrons released by the primary explosions flew off without hitting any more Uranium. Most of the shots were wasted, went wild.

Now a bungling rifleman, who might miss a lone tree, couldn't miss hitting some tree or other if he fired at random in a deep forest. Same with atoms. Imagine a mass of several pounds of Uranium 235, with a cavity in the center, wherein a single neutron is released. If it misses a few nuclei it will continue on until it finally hits one and explodes it. From one to four high-speed neutrons fly off from the explosion. Each of these eventually finds a nuclear target, so the explosions build up in a geometrical series.

Uranium 235 is Self Governing

Here would seem to be the basis for the catastrophic explosion already mentioned, but physicists have already learned that it cannot take place with Uranium 235, because nature has installed her own "fire extinguisher" in this element. The neutrons thrown off by atomic explosions are moving too fast to disrupt other atoms. They have to be slowed down artificially. Hydrogen atoms, in layers of water, are the best brakes. After the neutron has been slowed down enough it will find another Uranium nucleus and explode it. In this way you get a retarded chain reaction, such as you get with coal burning in air.

So you perforate your Uranium mass with voids or pipes full of water. When the reaction is started the water wastes the excess energy of the projectiles and the reaction goes on as a slow chain. Why not an instantaneous chain? Because if the reaction went faster than the water fed could carry away the heat as steam, the steam would be superheated to such a high temperature that it could not sufficiently slow down the neutrons and they would cease to smash other atoms.

Briefly, present experiments make it seem certain that a true chain reaction could be started in a mass of perhaps 5 to 50 pounds of Uranium 235, using very simple apparatus (perhaps none at all; competent physicists tell me that the neutrons in the cosmic rays always present should be sufficient to start the process). Thereafter the evolution of energy would proceed at a rate determined by the rate at which water was pumped through the mass. When water flow was stopped the evolution of energy would cease or reduce to a small value.

All water pumped through would be instantly converted to high-temperature steam.

Scientists on the Firing Line

The history of the laboratory work behind this sensational discovery is intensely interesting, but there is space here only for the briefest summary: in January, 1939, Drs O Hahn and E Strassman of Germany bombarded Uranium with neutrons, and thereafter found traces of lighter elements, having about half the atomic weight of Uranium.

Hearing of this, three American

groups, within a period of a few weeks, proved by tests that the bombardment does actually split Uranium into lighter substances, with tremendous energy release. First in this race, by a few days were Prof John R Dunning, Prof Enrico Fermi and collaborators at Columbia University. A few days later came confirmation from L R Hifstad, R B Roberts, M A Tuve and associates at Carnegie Institution of Washington.

Many laboratories in Europe and America immediately went to work on this problem, but none succeeded in getting a true chain reaction with commercial Uranium. It was suspected that Uranium 238, constituting over 99% of the Uranium used, was acting as "damper". The obvious next step was to test the three isotopes separately.

First they had to be separated. This was accomplished in the Spring of this year, first by Professor Nier of the University of Minnesota, and two weeks later by scientists in the General Electric research laboratory. Nier used a "mass spectrometer" in which a stream of ionized Uranium bromide was passed through a magnetic field. This field deflected the streaming Uranium atoms in inverse proportion to their weights and thus formed three little patches of 238, 235 and 234, respectively, on the platinum target. Thereafter the Columbia scientists (Prof Dunning, Prof Fermi, Dr E T Booth and Dr A V Grosse) were able to bombard each isotope separately. They found that 238 was not at all receptive, nor was 234, whereas 235 gave the spectacular results already described.

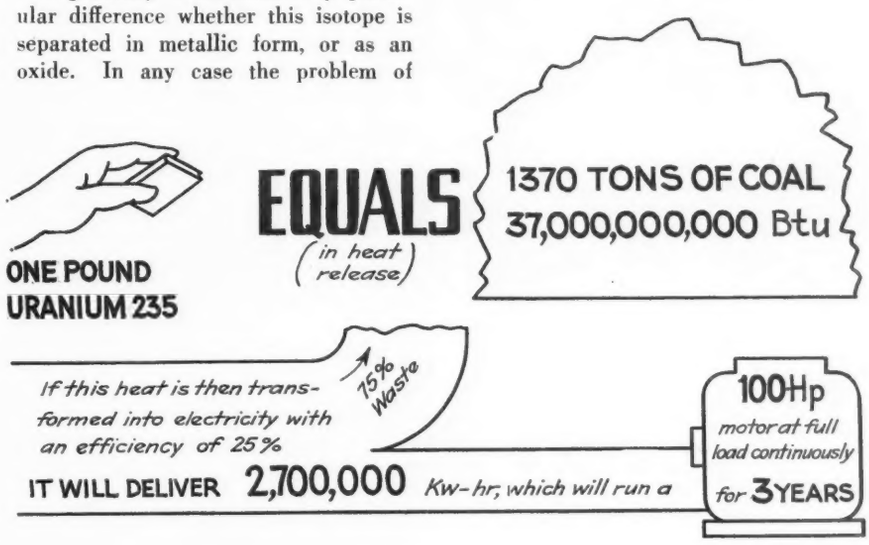
In all the laboratories, the first step in the bombardment technique is to produce very high-speed projectiles, such as protons. The protons are accelerated either by a straight high-voltage electrical field, or by an electromagnetic device known as the cyclotron. The cyclotron whirls the protons around in a gradually enlarging spiral at constantly increasing speed. The resulting high-speed protons are allowed to hit a beryllium target. This, in turn, gives off a shower of high-speed neutron projectiles to attack the sample of Uranium.

Supply of Uranium

The best Uranium ore is "pitchblende", which has been used for years as the commercial source of radium. At present there are pitchblende mines in Western Canada, in Australia, in the Belgian Congo and in Germany. There are no rich deposits in the United States, but some low-grade Uranium ore is found in Colorado in the form of Carnotite. Uranium oxide is 65 to 90% of the total weight of pitchblende.

Present price of Uranium oxide (U_3O_8) is about $5.00 per pound, whereas the commercial Uranium metal sells for about $40.00. It is easy to imagine that this could be reduced to $10.00 or less if a commercial demand arose. However, this pound of commercial Uranium metal would contain only 1/140 pound of the desired 235 isotope, so that the cost of the latter, even if there were no extraction costs, might be over $1000 per pound.

It probably won't make any particular difference whether this isotope is separated in metallic form, or as an oxide. In any case the problem of separating isotopes so nearly similar in all physical and chemical properties is one of enormous difficulty. This, more than any one thing, may delay for decades the application of Uranium 235 as a commercial fuel.



Future Applications

Waving aside all these practical difficulties, and looking forward to an imaginary future state in which they have been solved, it is interesting to attempt prediction of the effect on commercial generation of steam and power. To idealize the case, let us assume that Uranium cost per unit of energy output is negligible, and that plant investment and labor costs are the same as now.

In that case, for a power or steam station, the total possible saving would be the present cost of coal. In a central station this saving would run from 2 to 4 mils per kwhr. It would even be less (assuming no change in coal prices) if we should base our comparison on the higher thermal efficiency of the steam station of the future. In any case, this saving in the cost of raw heat would be important, but not revolutionary. It would be less important than the savings produced by the change from the carbon filament lamp to the tungsten lamp, or from the tungsten lamp to the fluorescent. The effect on process steam costs in industry would be more important, since the total amount of coal burned to make process steam is two or three times that used by the central stations.

Because of its extreme concentration of energy, Uranium 235 has an immense appeal to the imagination as the future fuel for house heating and for the powering of planes, autos, ships, etc.

In the household ten tons of coal could be replaced by the consumption of 1/140 lb of Uranium. With no improvement in conversion efficiency a car that runs 15 miles on one gallon of gasoline would run about four million miles on one pound of Uranium.

There is at least one joker in this delightful picture. In the case of the home you might have to stock up with fuel for the next thousand years, because (it now seems) the 235 would not "burn" unless you had a mass of at least five pounds. Same may hold for automobiles. Who would want to "fill the tank" for twenty million miles?

Fundamentally it would be a matter of fixed charges on the minimum workable Uranium inventory, and the "turnover, of that inventory. On the other hand, the inventory problem should not be too serious for the central station or industrial power plant of medium and large size.

Obstacles such as these make early practical application of atomic power on a substantial scale unlikely. Nevertheless, Uranium 235 gives us the "makings" of atomic power plants. In the light of the history of science and engineering, eventual application seems probable—perhaps within our lifetime.

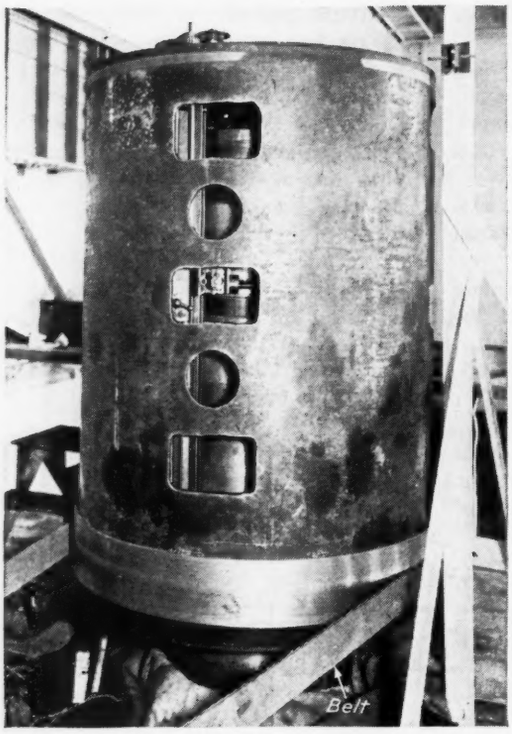


Fig. 1 (left)—Turning mill mounted on the shaft

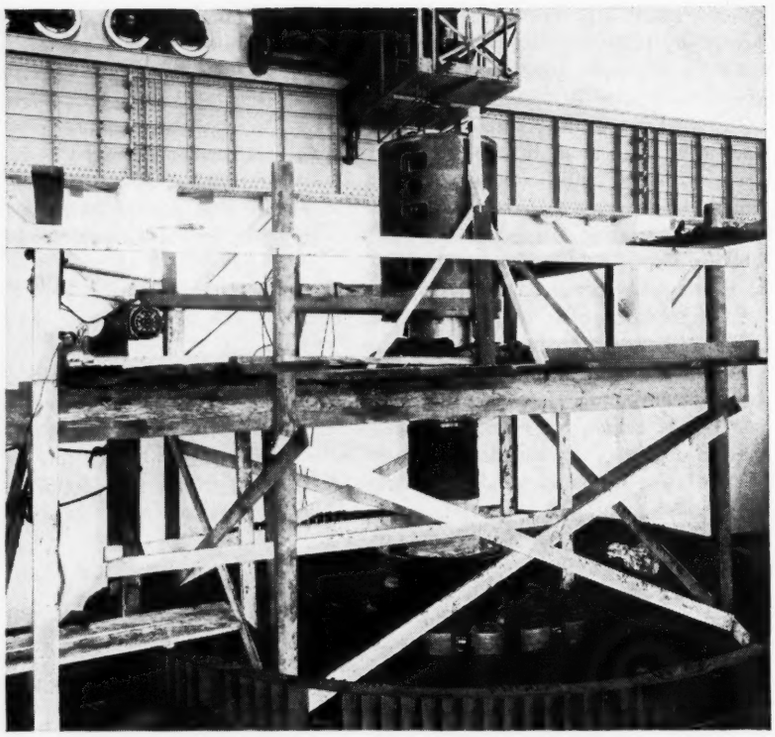


Fig. 2—Mill in place on the right belted to gearmotor

Large Hydro-Generator Shaft Repaired in Place

Ingenious turning mill trues 24-in.-diameter hydro shaft, keeping outage time to a minimum

By W H MITCHELL

▶ MODERN VERTICAL HYDROELECTRIC units of large capacities often present difficult and interesting maintenance problems. One such problem involved truing that portion of a large generator shaft where the thrust collar is. This collar, which supports a 450-ton rotor, is a 1-piece iron casting fitting tightly on a shaft, 24 in. in diameter.

In dismantling the unit a few times, heating the collar to remove it caused a small clearance to develop between the shaft and collar due to distortion from non-uniform heating. Also, the retaining ring which transmits the rotor weight to the collar did not make as good a fit on the shaft and collar as formerly. Because of wear on the shaft, collar and retaining ring, the shaft ran far out of true.

The job had to be done very accurately and the unit kept out of service as little as possible. Two methods of doing the work were considered: (1) removing the shaft from the rotor and sending it to a machine shop with suitable equipment, or (2) truing the shaft at the plant in place in the rotor.

Selecting the Method

We rejected the first method because of the time required to do the work and accepted the second as being most advantageous. Because of the size and weight of the shaft and rotor, we decided to rotate the tool about the shaft. This formed the basis of a design that included the development and construction of a truing mill for doing the work. Fig. 3 shows the details of the large welded steel-plate drum, with a head at each end, used to support the truing tool. Four sets of holes were cut on the circumference of the drum to give access to the tool and the shaft while the work was being done. A small lathe, with legs and head stock removed, was mounted parallel to the shaft on two brackets inside the drum.

Fig. 1 shows the turning mill mounted on the shaft. Through the openings in the drum, the lathe bed and tool carriage may be seen. Six 6-in. enclosed ball bearings on the lower head of the drum made this part rotate concentric with the shaft. We supported these bearings on an eccentric pin which permitted adjustment to the shaft.

We bolted the upper head of the drum to a flange. A ball bearing

mounted between this flange and a housing centered the top of the shaft in the rotating drum. The lathe-feed screw was extended through the upper head of the drum and driven by a pair of spur gears and a star wheel. Near the lower end of the drum on the outside we welded a band and trued it when the drum was machined. This band served as a sheave for driving the mill with an endless belt for flexibility from a 2-hp gearmotor.

Cutting Speed

We used a cutting speed of about 45 ft per min. This drive proved very satisfactory as the cuts showed no chattering of the tool and when one's hand was placed on the mill while the tool was cutting no vibration was felt. Fig. 2 shows the turning mill in place and the gearmotor mounted on the temporary platform.

Cuts about 0.008 in. deep were taken in truing the shaft, except for the final very light one to get a smooth finish. In all, six cuts were taken with a high-speed cobalt tool from the top of the shaft downwards as the cutting edge of the tool wore slightly, causing a slight taper. We found it preferable to have the large diameter of the finished section at the lower end of the cut. To prevent chips getting between the lower bearings and the shaft, we clamped a shield about the shaft to extend out over the bearings. We also spot welded a band about 2 in. high to the lower flange of the drum just beyond the outer circle of the lower ball bearing assembly, Fig. 3. In addition to truing the surface of the shaft, we refinished the upper face of the groove in which the retaining ring fits, to give a true surface for the top face of the ring.

A shaft length of 2 ft, 10 in. was refinished, which required 12 hours to make the first cut. We then doubled the cut width which reduced the time per cut to 6 hours. This gave even better results. The final cut showed the shaft to be about 0.001 in. larger at the bottom than at the top.

To insure a good fit of the cast-iron thrust collar on the revamped shaft, we counterbored the collar for a distance of 11 in. at the top and bottom of the existing bore for a cast-iron bushing in each counterbore. These bushings were made 0.015 in. larger than the counterbore of the collar. One of the bushings was covered with dry ice for about 8 hours, put into its counterbore and allowed to expand into place. We kept the second bushing in the ice for about 6 hours before it was expanded into place. No trouble was experienced in expanding these bushings into the thrust collar. A total of about 300 lb of dry ice was used to do the job. The collar was bored 0.001 in. smaller than the shaft and the top and bottom faces trued up. When reassembling, the thrust collar was first placed in a closed space and gradually heated with electric heaters until its bore diameter had increased 0.012 in.

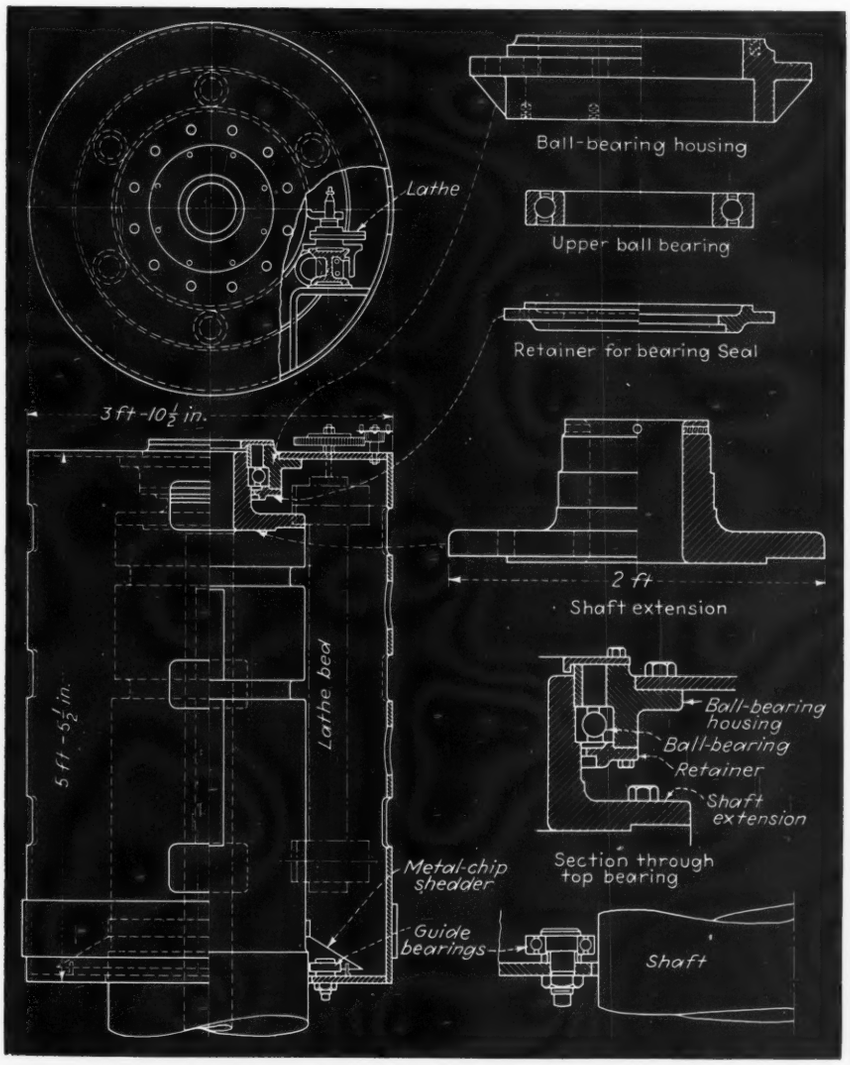


Fig. 3—Details of turning mill which carried small lathe around the shaft

Total Work

All machine work on the shaft required about 106 hours. A total time of 11 days and 5 hours was required to do the job from the time the unit was shut down until it went back on load. To start up again, we ran the unit at half speed and then increased the speed 10 rpm per hour until full speed was reached. On full load the shaft ran out of true about 0.01 in.; as there was this much clearance in the bearing bushing results were considered very satisfactory.

To dismantle the unit in the future we will not heat the thrust collar. The load will be taken off the collar by using the rotor brakes as jacks. Then the retaining ring can be removed and the collar forced up by reducing the pressure in the jacks. We revamped the piping of the jacks to permit using 1500 lb per sq in. pressure if necessary, which will be supplied by a hand pump and oil. By blocking the collar away from the thrust bearing when it is lifted and then allowing the rotor to lower, the process can be repeated until the thrust collar is forced off the shaft, or until it can be lifted off by the crane.

Central Stations Build

The following was received too late for publication in the article "Central Stations Build for 1941," page 64, May POWER.

PITTSBURGH—Work has started on the installation of the third 60,000 kw unit for the James H Reed Station. The schedule calls for completion July, 1941. The turbine-generator will be in an extension of the station, and one boiler of 350,000 lb capacity will be installed in an existing building.

Safe Stack Scaffold Cuts Painting Time

How to build and use an articulated steel scaffold for painting and repairing large stacks—described by W Elwood Rossnagel, safety engineer, Consolidated Edison Co of N. Y.

▶ PAINTING AND REPAIRING steel stacks can be accomplished in various ways, some of which have been explained in a previous article.* The special articulated scaffold of steel construction mentioned in that article and further described here has proven satisfactory in about 22 years of service on some 20 steel stacks. This scaffold, Fig. 1, is shown on a 22-ft diameter stack.

Sectional Platforms

Designed for use either outside or inside stacks of about 22-ft diameter, the scaffold consists of 12 trapezoidal-shaped platforms, Fig. 2, each about 5-ft, 6-in. inboard length, 6-ft, 7-in. outboard length, and 2-ft, 0-in. wide. The frame is constructed of $\frac{3}{16}$-in. steel plate bent to form an "L", or angle, shape with a 3-in. horizontal leg to support the floor boards and a 4-in. vertical leg which acts as a toe plate to prevent tools and other materials from rolling off. These bent plates are mitred and welded together at the corners of the platform. The floor boards, the only wooden parts of the scaffold, are 1 in. x $5\frac{1}{2}$ in., spaced $\frac{1}{2}$-in. apart and bolted to the platform frame.

Between the ends of the adjacent platforms are separators (Part 9 of Fig. 2) made in the form of an inverted "U". The horizontal web portion of the bent $\frac{1}{8}$-in. plate is 3 in. wide by 22 in. long and has vertical flanges at both sides 3 in. deep. Passing through the end toe plates of the adjacent platforms and through short lengths of tubing welded to the separator plate are two $\frac{3}{4}$-in. bolts 8-in. long, the nuts on which are left about 1-in. slack. Cotter pins are provided for security. On top of the bent separator plate is a hinged plate 3 in. x $\frac{3}{8}$ in. x 12 in. long which is thrown back onto the separator while the scaffold is being hoisted and swung out to form an outrigger and stabilizer during lowering and working.

The scaffold is necessarily discontinued at the ladder and, in order to tie the platforms together into a continuous ring around the stack, a steel bar (Part 6) or a $\frac{3}{4}$-in. rod is extended from the outboard corner of one platform to that of the other platform adjacent to the ladder.

At the eleven joints between platforms, and at the two scaffold ends at the ladder, are standard Patent Scaffolding Co hand-operated scaffold winches (Part 35) designed to accommodate about 250 ft of $\frac{5}{16}$-in., 6 x 19, galvanized-steel wire rope (Part 27) for suspending the platforms. These cables are eye-spliced with thimbles at the upper end for attaching to "sky hooks" (Part 3) which engage the top of the stack wall.

Operating the Scaffold

In raising the scaffold, the men "pump" the levers on the winches. In lowering, the main dog is held disengaged with one hand while the hand crank on the worm shaft is turned with the other. The winch parts are all doubly protected against failure, there being duplicate dogs on the lowering motion; main dog and worm drive hold while hoisting. Two of these devices would have to fail simultaneously to permit the winch to unwind accidentally.

To insure winding the cable in even layers on the winch drum during hoisting, a fairleader (Parts 7, 8, 11, 12, 15, 16, 25 and 28) is attached to the upper part of the winch frame, making it possible to feed the rope on the drum as desired.

Special plate brackets (Parts 4 and 5) are bolted to the lower end of the winch frame and from these brackets are suspended four hanger bars (Parts 13 and 14) which in turn are bolted to and support the corners of adjacent platforms. These hangers do not lie exactly in the planes of the brackets or of the platforms, and in order to avoid the necessity of fabricating them with slight right and left hand twists, some play is allowed in the bolt holes and about $\frac{1}{8}$-in. slack is left when placing the nuts on the bolts. All of these bolts, of course, have cotter pins.

At the ends of the scaffold near the stack ladder, only two hangers are required. These are attached to diagonally opposite holes in the two winch

Fig. 1—Twenty-two years' experience on 20 stacks have developed this scaffold for safe and rapid maintenance work. Stack shown is 22 ft in diameter

* *Safe Painting Steel Stacks*, POWER, May, 1940.

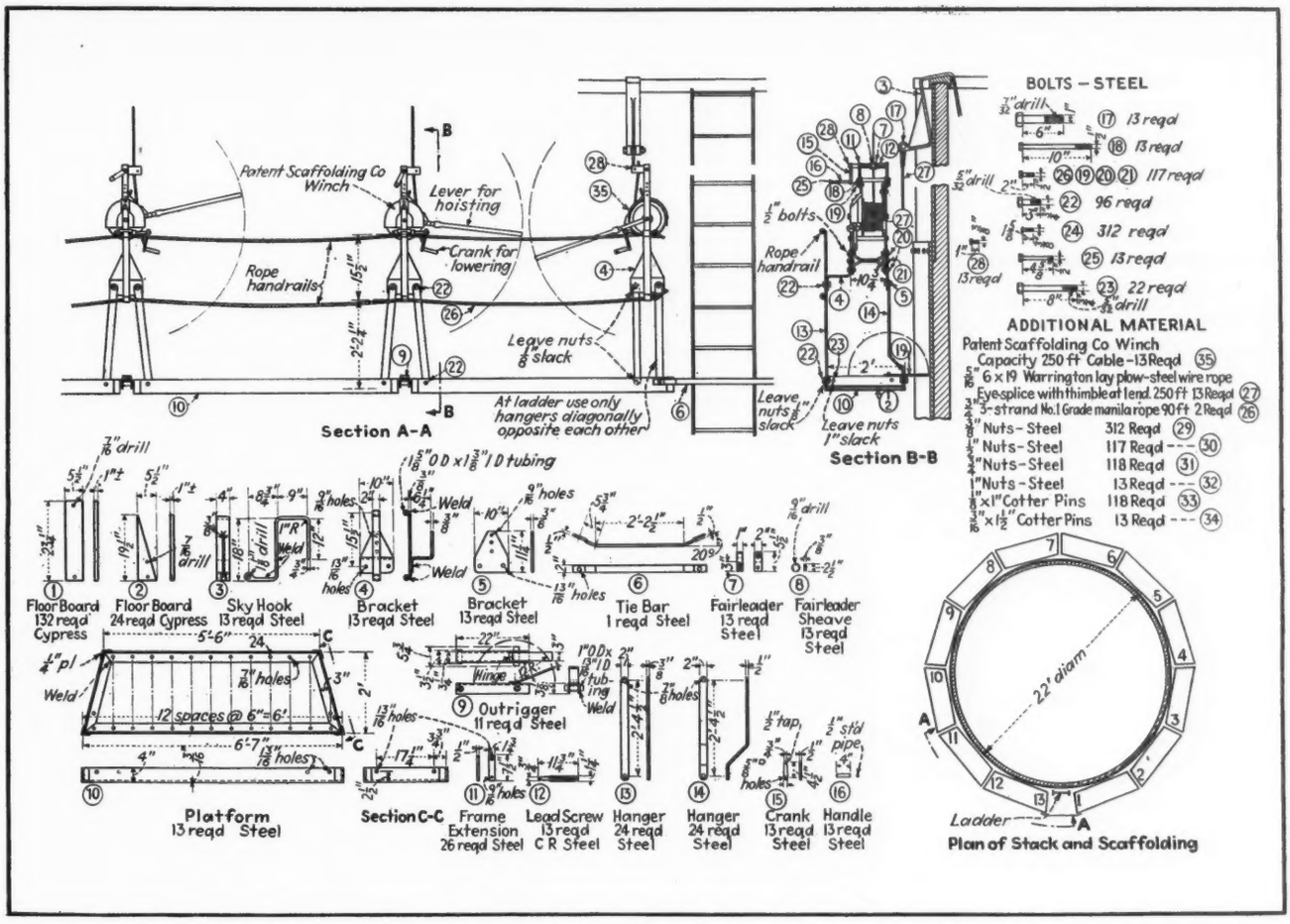

Patent Scaffolding Co Winch
Lever for hoisting
Crank for lowering
Rope handrails
Section A-A
Leave nuts 1/8 slack
At ladder use only hangers diagonally opposite each other
Rope handrail
Leave nuts 1/8 slack
Leave nuts 1" slack
Section B-B
BOLTS – STEEL
ADDITIONAL MATERIAL
Patent Scaffolding Co Winch
Capacity 250 ft Cable – 13 Reqd
6 x 19 Warrington lay plow-steel wire rope
Eye-splice with thimble at 1 end. 250 ft 13 Reqd
3-strand No. 1 Grade manila rope 90 ft 2 Reqd
Floor Board 132 reqd Cypress
Floor Board 24 reqd Cypress
Sky Hook 13 reqd Steel
Bracket 13 reqd Steel
Bracket 13 reqd Steel
Tie Bar 1 reqd Steel
Fairleader 13 reqd Steel
Fairleader Sheave 13 reqd Steel
Outrigger 11 reqd Steel
Platform 13 reqd Steel
Section C-C
Frame Extension 26 reqd Steel
Lead Screw 13 reqd C R Steel
Hanger 24 reqd Steel
Hanger 24 reqd Steel
Crank 13 reqd Steel
Handle 13 reqd Steel
22' diam
Ladder
Plan of Stack and Scaffolding

Fig. 2—Assembly and parts of scaffold showing articulated construction of wood-floored platforms and supporting-winch locations. Note hanger bar in Section B-B that permits passage between winch and stack wall without bending over beneath winch frame

brackets so as to keep the winch frame in a vertical position and the drum shaft pointing radially away from the stack center.

With the platforms thus supported and loosely tied together, the scaffold is sufficiently flexible to permit one winch to be raised a foot or more above the next. Thus it is not essential to keep the scaffold absolutely level, although it is desirable to maintain the platforms reasonably near a horizontal position. To accomplish this when hoisting, the men should pump rather uniformly at the winches. Some gangs have found it practical, and entertaining as well, to have one of their members sing loudly while all keep time with the levers.

To pass from one platform to the next, on the scaffold as originally designed, shown in Fig. 1, required that a man crawl under the winch. Later modifications to inboard hangers (Part 14) and brackets (Part 5) allow sufficient space for a man to pass between winch and stack wall by stepping over the offset lower ends of the hanger bars. The triangular openings between the platforms and the stack wall at the winches are small enough so that a man can not fall through. When the outrigger is hinged in the "out" position, it forms a convenient step at this location.

Provision is made at each winch bracket (Part 4) to support two lengths of ¾-in. No. 1 grade manila rope (Part 26) which act as a handrail along the outboard edge of the scaffold.

Completing the Circle

The purpose of the tie bar (Part 6) is to bind the entire scaffold into a unit and to have it completely encircle the stack while also preventing the ends near the ladder from moving away from the stack wall. Also, if by some stretch of the imagination, it could be assumed that twelve out of the thirteen suspension cables failed, the remaining cable would be expected to cause the entire scaffold unit to tilt and bind on the stack, which would effectively prevent it from dropping.

It is well to equip men climbing the stack ladder with body belts of webbing having forged steel (not malleable iron) snap hooks which can be attached to a ladder rung whenever they desire to stop and rest.

Design of the scaffold permits its use on the inside of a stack of the same diameter if only nine sections of platform form the circle. When inside the stack, the winches are reversed in relation to the platforms so that the rope railing is on the inboard (unprotected) side of the scaffold.

The erection of the scaffold, exclusive of any false work that may be required if the boiler-house roof slopes, can readily be accomplished in one work day. While some members of the gang are erecting the scaffold, a couple of painters start work on the balcony of the stack and the plates above it. On the second day, thirteen men (they are not superstitious when using this scaffold) place their paint pots and tools aboard and pump to the top of the stack just below the balcony. They then paint their way down to the roof, using ordinary brushes, making the entire operation in one 8-hr day on a 22-ft diameter stack 175-ft high above the boiler-house roof.

The men who use this scaffold, as well as those responsible for its design, feel that it affords adequate safety for a job of this nature. At the same time it is a practical device that greatly reduces stack-painting time.

Hints for Healthy Diesels

Engineers in medium-size plants can keep engines rolling at peak economy by following simple operating rules. S S Hansen, General Petroleum Corp, passes on experience learned in years of helping operators get best results. First article of three

▶ WE EXPECT A NEW DIESEL, properly operated, to produce power with high economy and reliability. However, in most diesel operations, changes occur which threaten the engine's ability to produce at minimum cost. In many cases, these changes take place gradually, and the operator fails to notice them. The engineer who says he has "no trouble" with his diesel may have become accustomed to minor mechanical irregularities and may not have noticed that operating costs have increased with deceptive slowness. Other diesel users may be fully aware that costs are too high, but lack a systematic plan for analyzing conditions to find the reasons and a program for curing the basic troubles.

Enemies of efficient and satisfactory diesel-engine operation cause most trouble in small municipal or utility plants operating engines of a few hundred horsepower and in isolated industrial plants. The big plant can afford adequate facilities for carefully safeguarding engineering routines, including well-equipped laboratories and highly-trained engineering personnel.

In extremely small plants, the amount of money spent each month is rarely enough to cause much concern, especially considering only the difference between excellent operating standards and average standards. However, in the medium-size plant, the cost of inefficient operation may be several hundred dollars per month, enough for the operator to worry about. Without laboratory facilities and high-priced experts, how can the operator of the medium-size plant keep his engines rolling at maximum efficiency with power costs cut to the bone? He's got to learn to be a "Chinese doctor" for his engines, to learn all the formulas and incantations that ward off the evil spirits stealing efficiency.

In this task, the experienced lubricating engineer can make many helpful suggestions based on his knowledge of all kinds of operators and all types of engines. To back him up he has the experience of co-workers in other territories, pooled through a central technical staff, and the data supplied by the company research laboratory. Since he can never hope to accomplish plant economies and improved engine operation by use of quality fuels or lubricants *alone*, the lubricating engineer must be even more conscious of possible improvements in a diesel plant than the operator himself. The suggestions which follow, in this and succeeding articles, are those I commonly offer to my customers. They are simple rules, but often neglected.

Mechanical Conditions

Excessive cylinder-wall wear bars any chance of attaining highest possible economy in a plant. Obviously, the diesel cylinder wears more at the top where it is exposed to the high temperatures of combustion and high ring pressures, than it does at the bottom. Normal rate of wear may be taken as around 8 or 10 thousandths of an inch, after several hundred hours of operation. Wear usually occurs at a faster pace while the engine is new, but if operating conditions are satisfactory this wear gradually tapers off to a minimum rate after the initial period. However, wear of more than 15 or 16 thousandths at the top of the cylinder should be considered abnormal.

Heavy wear of the cylinder bore imposes an increased burden on the piston rings. The rings must follow the contour of the cylinder wall as the piston moves up and down in the cylinder. Any tendency of the rings to stick in the grooves limits the sealing action and blowby occurs. The hot blowby gas sweeping over the surface of the piston ring scours the oil film from the cylinder wall and thus encourages increased metallic friction and abrasion. Excessive blowby means reduced compression and poor combustion.

More and more it is recognized that water formed in the cylinder as a by-product of combustion constitutes one of the principal causes of upper-cylinder wear. As is well known, each gallon of fuel oil, in burning, forms a little over a gallon of water. Most of this water passes off with the exhaust gas as vapor, but part of it condenses in the cylinder and part escapes the piston rings and contaminates the crankcase oil. It is interesting to note that the dewpoint of the vapor in the cylinder is lower by virtue of the fact that the air in the cylinder is held under high pressure, particularly at the end of the compression stroke and beginning of the power stroke.

If the engine operates cold, water mixes with the lubricating oil on the upper part of the cylinder walls and prevents proper "wetting" of the oil film over the metallic surfaces. In addition, the water absorbs CO_2, formed as a byproduct of combustion, to make carbonic acid. This carbonic acid may become sufficiently concentrated to corrode the upper cylinder walls and piston rings, especially during idle periods. For this reason, many operators find it good practice to pour a few ounces of lubricating oil into the combustion space during idle periods.

Edges of Oil Rings

There are many other causes of cylinder wear, such as dust or other abrasive matter in the intake air, abrasive matter in lubricating oil or fuel, lack of lubrication, or use of an improper oil. One of the principal causes of excessive cylinder-wall and piston-ring wear is the effect which a sharp corner on the upper edge of the piston ring produces. This razor-like edge scrapes the oil film from the cylinder wall into the combustion space where sticky, carbonaceous deposits form. The operator should see that all upper edges of all compression and oil rings are rounded off, as shown in Fig. 1.

A rounded upper edge enables the piston ring to ride over the oil-film on the cylinder wall and greatly facilitates oil-film formation. This is especially true in engines where a mechanical lubricator supplies the lower part of the

cylinder wall or where lubrication depends on splash from the crankcase. A square edge on the lower surface of the ring meets with no objection inasmuch as this scrapes any excess oil back into the crankcase or sump for re-use.

Ring Sticking

Ring sticking is one of the most prevalent causes of excessive cylinder wear, as the resulting blowby strips the oil film from the cylinder walls. Residual fuels are more prone to cause wear than distilled fuels. Overheating the engine may thin the lubricating-oil film to such a degree as to cause wear. Water, sulphur or other corrosive elements in the fuel are also detrimental.

Maintaining bearings in proper condition is very important. Any bearing wear permits a constant flexing of the crankshaft. This is especially true if one main bearing wears more than another. To appreciate this point, visualize for a moment the pressure exerted at the beginning of the power stroke on an average diesel piston of about 14-in. diameter. This total pressure approximates 75,000 lb, and with combustion taking place several hundred times a minute, one can easily see that even the most rigid shaft will flex if it is not adequately and correctly supported. If the shaft fails to seat in the bearing over its entire supporting area, the pressure will be concentrated at the ends of the bearing where failure will usually occur.

Shaft distortion may result from running the engine at a speed beyond that for which sufficient counterweights are provided, from weak crankpin webs, from lack of crankshaft rigidity, or from misalignment. Flexing occurs not only in the shaft, but may take place over the surface of the bearing, or in the bearing housing. This may often be traced to poor bonding of the bearing material; examination of the bearing ends will reveal small cracks or checks running from the outside toward the center. It is always good practice to make visual examination of the bearings for this condition, at overhaul or inspection periods. Bearing failure means immediate shutdown with resultant power outage and necessary expense for repairs.

Abnormal bearing wear encourages excessive throw of lubricating oil. This may mean that the next succeeding bearing or bearings on the shaft will not receive a sufficient amount of oil. Excessive throw also encourages too-high cylinder consumption.

Fuel nozzles should not be allowed to become clogged or worn. The operator should carefully check the injection timing. It is quite possible that the cetane number of the fuel in use is not the same as that on which the engine was adjusted and tested during its manufacture. Often fuels of varying cetane rating are used without regulating fuel-injection timing in accordance with the combustion characteristics of the fuel. More will be said about this point later on in this series of articles.

To summarize: no operator can expect to secure economical operation from an engine if cylinder liners are badly scored or worn, if pistons or rings are in bad shape, if bearings are worn or improperly adjusted, and if fuel injection nozzles are not clean and in good condition. Any attempt to establish a first-class operating routine can only be started after the engine is put into good mechanical condition.

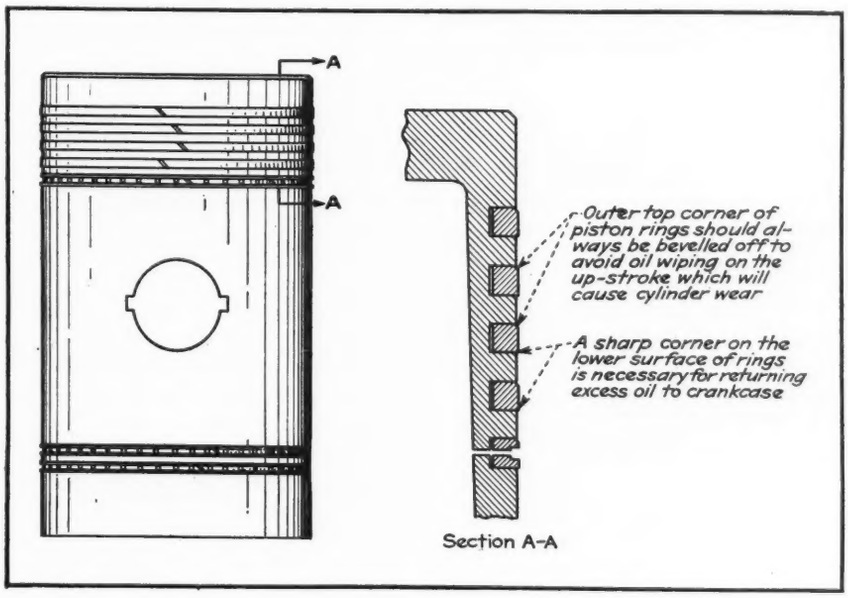

A
A
Outer top corner of piston rings should always be bevelled off to avoid oil wiping on the up-stroke which will cause cylinder wear
A sharp corner on the lower surface of rings is necessary for returning excess oil to crankcase
Section A-A

Fig. 1—Correct piston-ring shapes for proper cylinder lubrication

Intake-Air Condition

It is hard to understand why many diesel operators are indifferent to the use of air cleaners, or to their proper maintenance. Abrasives in the intake air form a principal cause of piston-ring and piston-land wear. Dust floats in the air at all times; chimney and stack discharges add soot and cinders; agitation of atmospheric air raises fine particles of sand and grit. Such substances, if fine enough, may be carried over considerable distances by wind or moving air currents. Actual count by the U S Weather Bureau shows that each cu in. of average air contains 115,000 dust particles.

Operators usually think of any diesel-cylinder deposit as a "carbon deposit" from the lubricating or fuel oil. Laboratory analyses of engine deposits often reveal, however, that they are composed largely of dust and dirt. The unburned portions of the fuel or lubricating oil simply act as binders for this material. Many of the byproducts of combustion are gummy and sticky and form excellent adhesives for dirt in the intake air. Taking an average of 3 cu ft of suction air per minute, per rated engine hp, a 1000-hp engine operating 8000 hours yearly will draw in 1,440,000 cu ft of air which, with a content of one gram per 1000 cu ft, will deposit 1,440,000 grams or 206 lb of dirt on the cylinder walls. In California and other Western states, air pollution, consisting mainly of sand, often rises to several lb per 1000 cu ft, during windstorms.

Troubles from Dirty Air

Dirty intake air directly caused bearing failure in the case of several 2-cycle engines in my experience. In one particular case, a 2-cycle engine was adjacent to an ore-crushing plant. The abrasive dust entered the crankcase through the breather. Repeated bearing failures occurred until a suitable filter was put on the crankcase air intake.

The average home owner equips his house with screen doors on both front and back entrances—he would look rather foolish if he put a screen on the front and left the back unguarded. The engine operator who makes provision for filtering the air to the cylinders (on a 4-cycle engine) but neglects the crankcase breather is just as inconsistent. The dust makes trouble, no matter where it comes from.

Many efficient air filters are available

commercially, and the operator with spare time can "roll his own" if need be. It is nearly always preferable to place the air-intake line near the roof, in as cool a spot as possible. This safeguards against drawing excessive quantities of dust from the ground and provides for admission of cool air to the cylinders. Air-intake protection is vital, and the cost of a proper installation represents an infinitesimal part of the capital investment in a plant, often being less than 50 cents per rated engine hp.

Cooling System

The ideal cooling system for a diesel is, of course, the closed circuit in which distilled water is used or in which a systematic program of water treatment is followed. It is somewhat surprising to observe the carelessness shown by many operators who add makeup water to the system without providing for correct treatment. Of course, with an open system and no provision for water treatment, conditions will be worse. In either case, lack of attention to water conditions causes scale formation in the engine jackets and the cooling coils. Even in areas where the water runs relatively soft, mud, dirt, and silt frequently deposit in the jackets.

Scale acts as an effective heat-insulating material and makes it difficult for heat to flow from the combustion gas and the hot internal parts of the engine to the cooling medium. An operator may unwittingly subject his engine to severe abuse from this condition, simply because he does not know it exists. The temperature of the cooling water may stay reasonably low even when excess scale is present. This results, of course, from the fact that the heat from the combustion-chamber envelope does not flow into the cooling water.

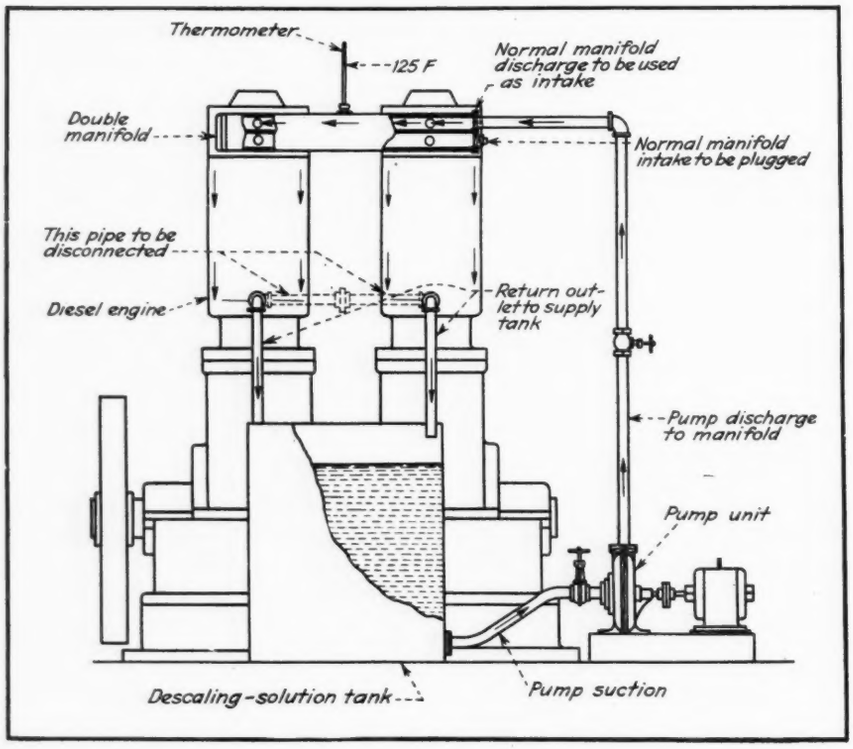
Both engine builders and users are increasingly conscious of the fact that cooling-water temperatures should never be allowed to drop much below 140 F. A cold-running engine facilitates water formation in the cylinders. Heat losses into the cooling water may be high on the compression stroke, with resultant poor fuel economy. Lubricating oil may distribute with difficulty in a cold-running engine. All these factors lead the diesel engineer to the conclusion that higher jacket temperatures are beneficient and economical.

Keep Jackets Clean

However, it is unsafe to operate an engine loaded with scale at high circulating-water temperatures. To be safe, the operator must be sure that jackets are clean and that heat transfer into the cooling water is not impeded. It is always advisable to install thermometers on the cooling-water lines into and out of the cylinders; they should always show at least 20 F increase. If flow is sufficient, this assures the operator of adequate cooling.

If the jackets become scaled, the operator should consult one of the companies making a regular business of supplying descaling chemicals. When acid treatment is used, suitable organic inhibitors will guard against any injury to the cooling system. The treatment depends, of course, on the scale present. Calcium and magnesium carbonates are relatively easy to remove. In cases where the cooling water contains high percentages of silicates this is not true, and a special treatment may be required. Fig. 2 shows a method of circulating an acid solution through the engine jackets.

Fig. 2—Method of descaling diesel water jackets



Load Conditions

A smoking engine often indicates load irregularity, and smoke is most likely to appear at light loads or overloads. At light loads the average temperature in the combustion chamber may drop several hundred degrees, due to the decreased amount of fuel being burned. As a result, the fuel ignites late, combustion is incomplete when the exhaust valve opens, and fuel is emitted in a partially burned condition. For the same reason, smoke occurs frequently immediately after starting up an engine.

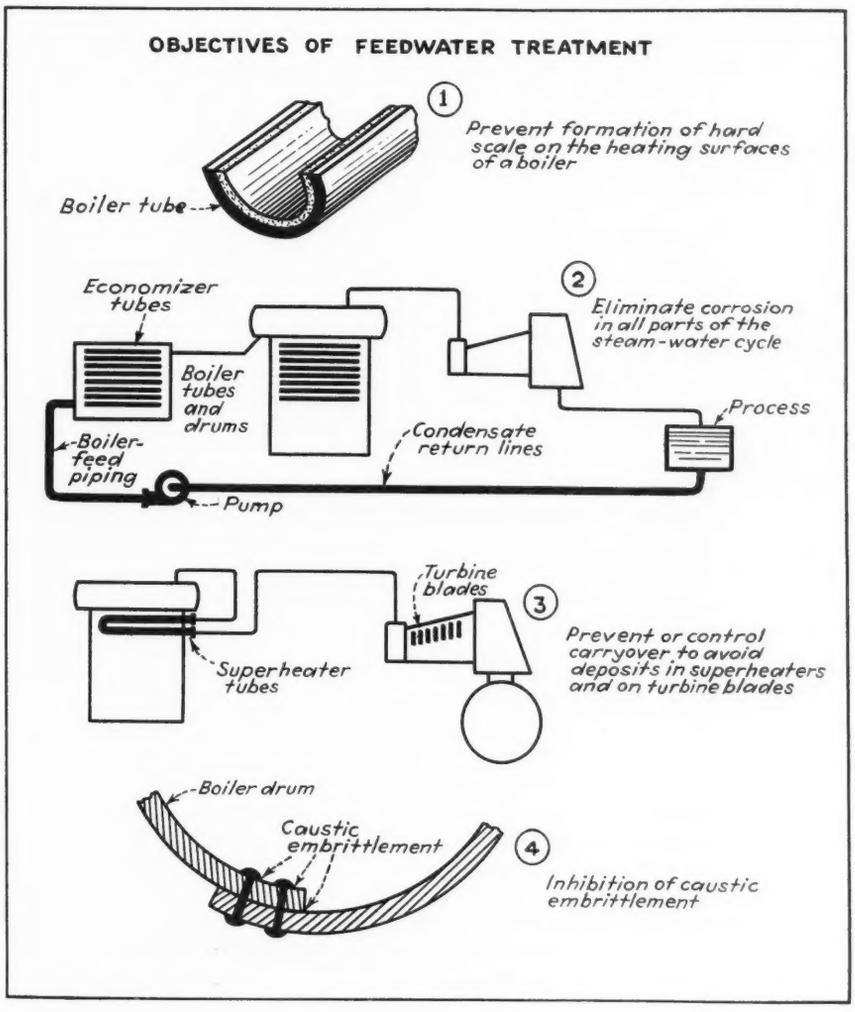
Diesels are usually rated according to the maximum hp developed at the "smoke limit." At any given speed, enough air enters the cylinder to produce complete combustion of a definite amount of fuel, depending on the amount of turbulence present in the cylinder. If more fuel is injected, overloading the engine beyond the rated hp, or smoke limit, there will not be enough air present to burn all the fuel and the unburned fuel will show as smoke.

Watch for Overload

The most dangerous condition of operation is overload. This is particularly so in a multi-cylinder engine when one cylinder carries more than its just share of the load. Cylinder and piston temperatures may become excessively high, and such irregularities of combustion encourage formation of sticky, carbonaceous deposits. When the piston rings begin to stick, blowby starts, with all the attendant evils. When the condition becomes sufficiently aggravated, metallic friction and abrasion begin, and in severe cases piston seizure may result from this condition of unbalanced load. For these reasons, no plant can afford to be without a suitable pyrometer, with thermo-couple wells in each exhaust port. A daily log should be kept of the operating temperatures of each cylinder and the load should always be balanced within 30 F between cylinders.

Feedwater Treatment—1940

"Rule of thumb methods must be discarded" says C H Fellows, in his review of feedwater-treatment progress before the ASME*. Here the POWER staff interprets and illustrates the latest summary of objectives, methods and materials



▶ FEEDWATER TREATMENT in modern plants has come to mean a great deal more than dumping a scoopful of compound in a mixing tank and feeding the solution into a pump suction. It includes skilled treatment of the makeup water before it enters the boiler-feed system and the controlled addition of materials to produce chemical effects within the boiler itself.

The elementary aims and accomplishments of the many kinds of available treatment are simple. Application of the correct combination of these elements to an individual case requires accurate chemical knowledge and brings in the all-important matter of dollars and cents. For example, a plant operating on a condensing cycle with evaporated makeup needs little protection against scale formation in boiler tubes. But an industrial plant, operating at high makeup, needs a full-grown treatment system to protect against scale and carryover, and the primary object should be to *reduce all solids* in the boiler water to a minimum.

The objectives of feedwater treatment have not changed with increase in operating pressures. Briefly, these are:

(1) The prevention of hard scale on the heating surfaces of the boiler, (2) the elimination of corrosion in all parts of the steam-water cycle, (3) the prevention or control of carryover to preclude adherent deposits in superheaters and on turbine blades, (4) insuring against caustic embrittlement.

In most instances, the primary reason for treatment is the prevention of scale. Most waters can be treated chemically to prevent scale by soda ash or one of the sodium phosphate salts. Soda ash is used either internally in the boiler water or as part of a lime-soda softener. The phosphate salts have been considered by a number of chemists as a preventive of embrittlement, they absorb small amounts of oil that may enter the system, and are usually employed only as internal boiler-water treatment.

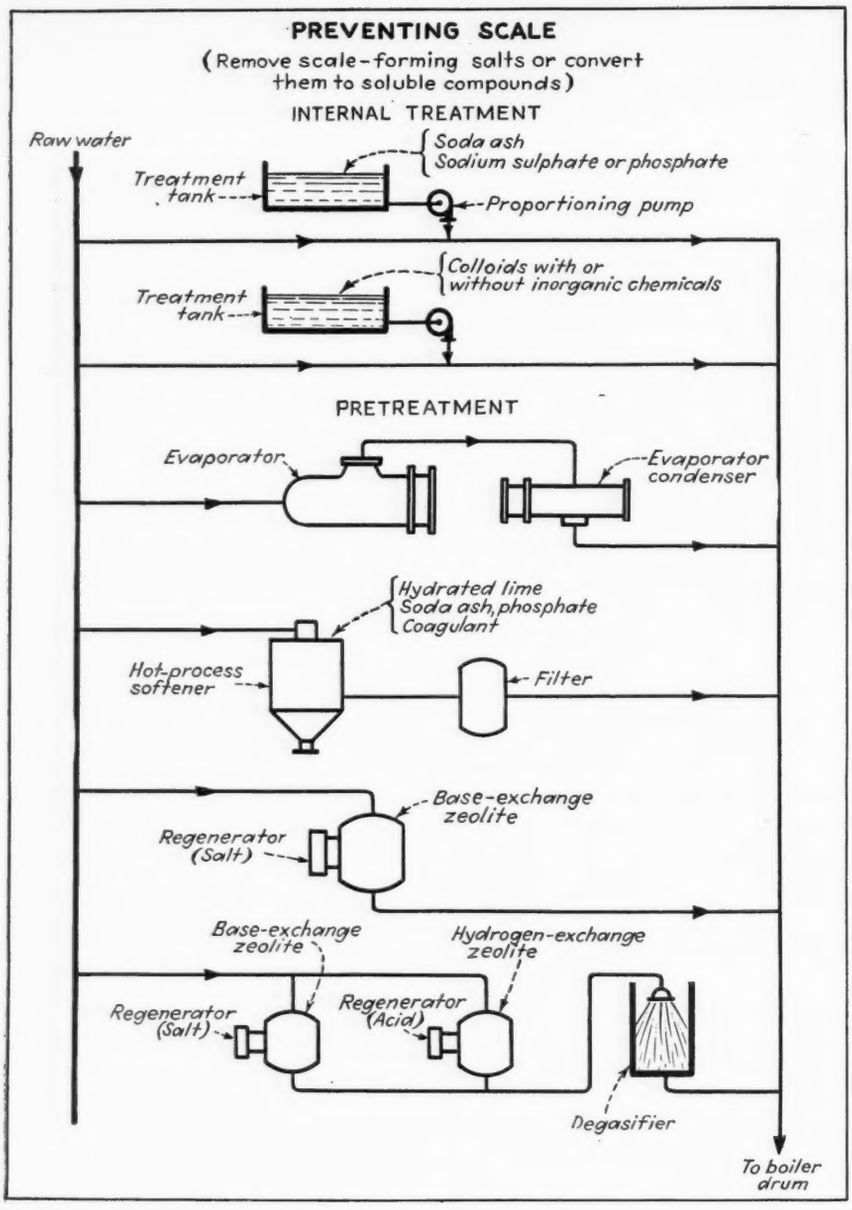
Zeolites

Natural or artificial zeolites offer another means of pretreatment. The usual base-exchange process raises the pH of the feedwater and the zeolitic material is regenerated with a common salt solution. A recent development is the acid zeolite, regenerated with sulphuric acid, which is used in conjunction with the base-exchange process to reduce total solids content by converting carbonates to CO_2, with removal of the latter as a gas in a degasifier.

Standard hot-lime-soda softeners have been made more effective by use of coagulants to increase percentage removal of scale-forming salts and by the addition of phosphate as internal treatment to assure more complete removal of residual calcium and magnesium.

Colloidal treating compounds are receiving much attention. They may be divided into two general classes: (1) those which contain only a single salt or element and are used primarily as oxygen scavengers and (2) those which combine with an organic material the commonly used soda ash or phosphates. Among the first class are those which contain colloidally fine metallic iron or iron salts. In the second class are ex-

*Worcester, Mass., May, 1940.



tracts of seaweed, hemp, and sugar cane with which soda ash and phosphates may or may not be combined to form the complete treatment. Exact knowledge of the reactions of many of these organic compounds in boiler water is not available, but reported success in their use has become widespread, especially in lower-pressure small industrial plants.

Several so-called electrolytic systems depend upon an imposed voltage to redirect the natural movement of ions away from the boiler metal thus preventing deposition of scale or oxides. Their successful operation in boilers has not been conclusively demonstrated.

Many of the treatment processes applied primarily for the prevention of scale are also useful in combating corrosion. In high-pressure steam generators, corrosion presents a more serious problem than does scale. Even though all scale-forming salts are removed from the water by evaporation of makeup and by external treatment, corrosion of the metal can still proceed. In fact, the complete removal of scale-forming salts increases the tendency toward corrosion at higher operating temperatures of boiler water. Dissolved gas, principally oxygen, but also carbon dioxide, is usually the offender. Too much emphasis cannot be placed on the necessity for oxygen-free feedwater if serious corrosion is to be prevented.

Deaeration

Deaeration is the most commonly used method of oxygen removal in large power plants. It is not entirely adequate in all cases. Even though deaerators may completely remove oxygen from the water entering them, operating conditions often allow spasmodic entry of air beyond the deaerators. Treatment to "fix" the oxygen in such cases may be sodium sulphite, colloidal iron, or organic materials such as the tannins, chestnut extracts, or other similar reagents.

Fear that sodium sulphite might break down in solution has given way to the present opinion that low concentrations required to combat the small amount of oxygen in normally functioning boilers will not decompose. Trouble may result, however, from high sodium sulphite concentrations or in "dry" areas resulting from faulty circulation.

Removing CO_2

Carbon dioxide as well as oxygen is now looked upon as being a primary offender in the development of corrosion. The removal of this gas from systems handling large quantities of condensed steam materially reduces the corrosion of lines carrying the condensate. Treatment adopted for raw waters containing high concentrations of bicarbonate and carbonate salts involves acidification with sulphuric or phosphoric acids, aeration or gasification, followed by final deaeration.

Grooving, pitting and cracking that are not the result of oxygen corrosion, have been found on the steam side of boiler tubes. Studies point to imperfect circulation as the fundamental cause, permitting direct attack of the metal by solutions in contact with it. While this type of attack can undoubtedly be controlled by chemical means, it would be much more logical to eliminate the cause of poor circulation by mechanical methods in the design of boilers. The industry is now in a position, however, through research in the selection of alloy tubing, to combat the destruction of metal in high-temperature steam generators by providing a mechanical environment that is not reactive.

Preventing Carryover

Carryover of boiler water into the steam space is being prevented with considerable reported success by the use of steam washers of a variety of designs. Even with washers, however, the power-plant chemist attempts to control foaming of the boiler water by maintaining proper concentrations of dissolved and suspended solids.

Laboratory work evaluating the foam-producing properties of boiler-water salts indicates that some salts and some combinations of salts produce carryover at lower concentrations than others. The physical state of precipitated solids is a controlling factor. In certain cases, maintaining a ratio of 4.4 to 1 of sodium sulphate to sodium hydroxide has been found to prevent adherent deposits on turbine blades.

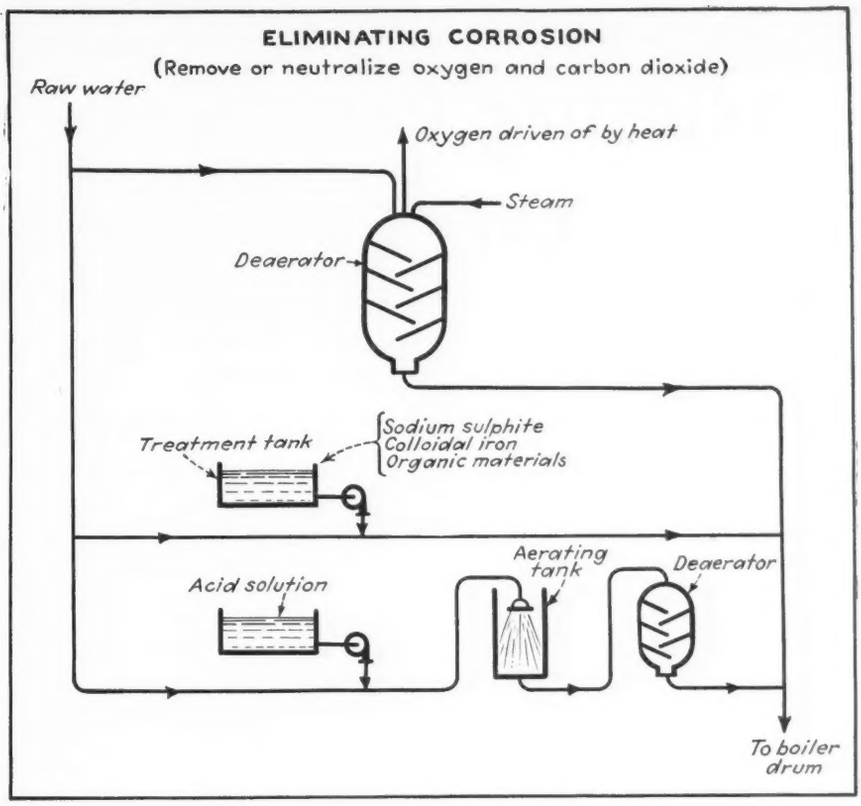
Concerning embrittlement, a review of operating experience has indicated that maintaining the ASME ratio of sodium sulphate to total alkalinity has resulted in such a high concentration of dissolved solids in the boiler water that it was impossible to operate without violent carryover. Necessity has required operation of many high-pressure boilers contrary to rules, yet no dire effects have resulted.

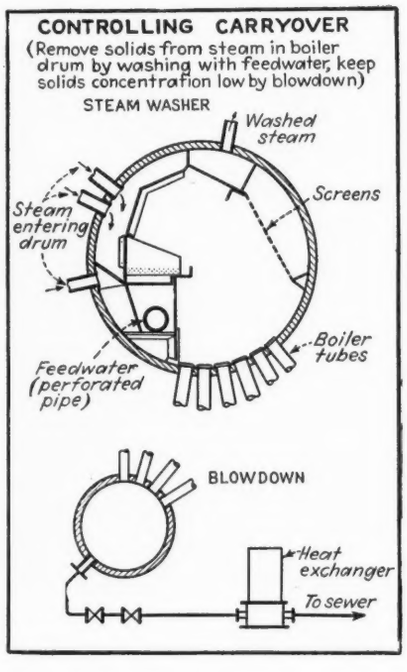
Why No Embrittlement

A number of explanations can be offered. Among these are the welded construction of high-pressure drums which precludes possibility of seams and crevices in which boiler water may concentrate to such values as 50,000 to 100,000 ppm of sodium hydroxide necessary to induce intercrystalline corrosion, a factor in the development of caustic embrittlement. Stress relieving, part of standard welding practice, also reduced the possibility of highly stressed metal, another necessary factor for embrittlement. Regardless of the reasons, there is a great deal of operating experience that indicates no evidence of embrittlement in high-pressure boilers where the ratios are not maintained.

A subcommittee of chemists, functioning under the ASME Boiler Code Committee, is reviewing operating data and relating it to the recent findings of research in an effort to modify the code requirements in line with present knowledge. As more information is gained through research and channels of practical experience, its release to operators may be expected.

In the treatment of water for high pressure boilers, rule-of-thumb methods must be discarded and the problem placed in the hands of thoroughly experienced and competent chemists who can apply the laws of chemistry and chemical reactions to a problem now requiring highest skill and most precise manipulation. No single method will apply to all cases and it is the intelligent combination of several methods or portions of methods that produces a complete system of treatment.





Scale is Dangerous

In high-pressure boilers, even a small amount of scale is dangerous and sound treatment should guarantee protection in event of condenser leakage or other unusual circumstance. If the boiler feedwater is so free of dissolved alkali-producing salts that the desirable pH range of 10.5 to 11.0 is not attained, it may be necessary to add an alkali salt to the boiler water. From this consideration arises the question of protection against embrittlement and the natural procedure would be to add sodium sulphate in accordance with ASME suggestions. However, the presence of sulphate in the water, together with the possibility of leaky condensers admitting raw water containing scale-forming salts, would make the chance for the deposition of hard scale highly favorable. Further treatment would be necessary to counteract that tendency. Then, since phosphates in proper concentration are preventive of embrittlement (up to roughly 400 lb operating pressure), the logical treatment would be to inhibit embrittlement with phosphate in excess of the value necessary to remove scale-forming salts, thus requiring the addition of only two chemicals (caustic and sodium phosphate, for example) instead of three.

There is a tendency in the treatment of boiler water, to add more chemicals than are actually necessary—to overtreat—and thus fill the boiler with unnecessary and undesirable quantities of both soluble and insoluble salts. This practice increases probability of carryover and requires excessive blowdown.

Keep All Salts Low

A good fundamental objective, where economically possible, is to reduce all salts in the boiler water to a minimum. In most high-pressure boilers the concentration of dissolved solids is maintained at 500 ppm and lower. The effectiveness of any treatment will be greatly enhanced by the judicial use of coagulants, such as sodium aluminate and some organic compounds, to flocculate the precipitated and suspended solids.

Industrial plants requiring a high percentage of makeup are prone to use processes (because of installation expense) that do not reduce the solid content of the water to a minimum and to depend on direct feeding of chemicals to eliminate scale. Such systems require excessive blowdown, involving heat exchangers and the like, to avoid carryover.

Adjusting Centrifugal-Pump Speed Cuts Operating Costs

A Peterson, chief engineer, Pump and Compressor Dept, De Laval Steam Turbine Co, shows how cost of operating waterworks and boiler-feed pumps driven by constant-speed motors can be reduced by adjusting speed with hydraulic couplings

▶ MANY CENTRIFUGAL PUMPS operate under conditions of varying capacity or head, or both. These include waterworks when the pumps discharge directly into the mains, boiler-feed pumps where the demand for water is regulated by steam demands, and where discharge is through a fixed orifice. In these and other applications large power savings can be made if the speed of the pump is adjusted to suit the head and capacity demands.

In the case of a steam-turbine or dc motor drive, the power saving nearly corresponds to the decrease in head. Speeds of dc motors are not generally as high as desired for boiler-feed pumps and direct current is ordinarily not available for driving waterworks pumps, while variable-speed ac motors are complicated and costly. The squirrel-cage induction motor, the most simple and reliable of all types, is inherently a constant-speed machine.

Hydraulic Couplings

For adjusting the speed of centrifugal pumps driven by constant-speed motors, hydraulic or magnetic couplings offer many advantages. Variable-speed hydraulic couplings have been used extensively in this country for fan drives. During recent years, however, they have been applied in other fields. For example, high-speed centrifugal compressors have hydraulic couplings between their driving motors and speed-increasing gears. More recently, variable-speed hydraulic couplings have been adopted for two important waterworks installations, one at Knoxville, Tenn., and the other at Kansas City, Kansas.

Other installations include three large, high-pressure, boiler-feed pumps driven by 2000-hp, 1750-rpm motors through variable-speed hydraulic couplings and speed-increasing gears. The pinion of the gear drives the pump at a maximum speed of about 3600 rpm. to develop 1600 lb per sq in. A large boiler-feed booster pump on order requires about 1000 hp at 1750 rpm. to be driven through a variable-speed magnetic coupling.

The saving of power made possible by variable-speed drive is apparent from a brief description of the two water-works installations mentioned above, engineered by Burns & McDonnell, Kansas City, Mo. The Knoxville unit, Fig. 1, has now been in operation for a number of months. It consists of two De Laval pumps connected in series and driven through an American Blower Co hydraulic coupling by a 1250-hp, 900-rpm Westinghouse synchronous motor. These pumps deliver 16 mgd (11,110 gpm) against a 350-ft maximum total head when operating at a speed of 873 rpm. This speed corresponds to a normal 3% slip in the coupling. Normal operating head is 325 ft, and the discharge ranges from about 5550 to 11,800 gpm. Theoretically, power savings expected from the variable-speed coupling have been fully realized.

The Kansas City installation, Fig. 2, is larger than Knoxville's and consists of two De Laval pumps connected in series and driven through an American Blower Co hydraulic coupling by a 2000-hp, 720-rpm Westinghouse synchronous motor. The unit has a maximum capacity rating of 25 mgd (17,350 gpm) when pumping against a 325-ft maximum head, at a pump speed of 700 rpm. The pumps will also deliver 13,900 gpm against a total head of 380 ft. These two points determine the shape of the head-capacity curve A_1, Fig. 4, for a constant speed of 700 rpm. Normal service conditions require a total head of 300 ft.

It has been estimated that the pumping unit will operate approximately 85% of the time at rates less than 13,900 gpm, and that during a consid-

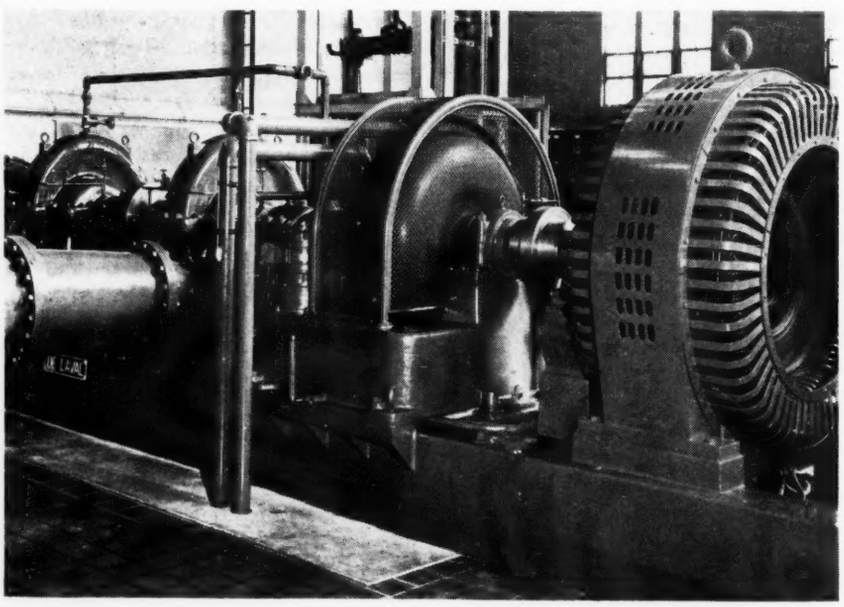


Fig. 1—Two 16-mgd centrifugal pumps operating in series and driven by a 1250-hp, 900-rpm synchronous motor through a variable-speed hydraulic coupling

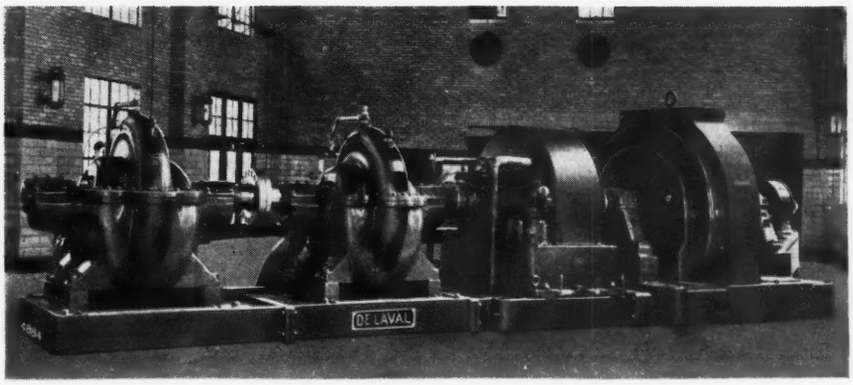


Fig. 2—Two 25-mgd centrifugal pumps operating in series and driven by a 2,000-hp, 720-rpm synchronous motor through a variable-speed hydraulic coupling

erable portion of the time the head will be between 300 ft and 255 ft. Curve B_1 represents operation against a constant head of 300 ft, obtained by speed regulation through the hydraulic coupling.

At Kansas City, the large difference between maximum designed conditions and that obtained under normal operation is found in many other pump installations now in operation or projected. This is because of unforeseen demands or the desire to have a safe pressure margin.

Horsepower Output

Curve *A*, Fig. 4, shows horsepower output of the motor if the pumping unit were operated at a constant speed of 720 rpm, when connected directly to the motor. When delivering 17,350 gpm against 325-ft total head, the pump requires 1640 bhp. At 13,900 gpm and 380-ft total head, the shaft horsepower would be 1,557. If a constant head of 300 ft is maintained in the system by throttling, curve B_1, the horsepower would still be according to curve *A*.

Curve *B* shows the brake horsepower required at the motor coupling to operate the pump against a constant head of 300 ft, for all capacities from 10,500 gpm up to 17,350 gpm. The shaded field indicates the power saving. This saving is considerable, particularly at deliveries below 13,900 gpm, at which point it amounts to 1557 − 1400 = 157 hp. In most plants the cost of current is such that this relatively large saving in power would justify considerable additional investment to obtain it.

In the operation of boiler-feed pumps, particularly for high pressures, variable-speed couplings will in many cases save considerable power. As a number of heaters, economizers, etc, are ordinarily installed between feed pumps and boilers, the pump pressures required are lower at light loads than at maximum.

Operating characteristics for a boiler-feed pump proposed for a large public utility plant are shown in Fig. 3. Curve A_1 is the head-delivery characteristic of the pump at constant speed and *A* the corresponding brake-horsepower curve. Curve B_1 is the actual system head-capacity curve to which the pump can be adjusted by running it at different speeds. Curve *B* represents brake-horsepower output of a motor connected to the pump through a variable-speed coupling, which must transmit a maximum of 856 hp. At 60% capacity, or 450 gpm average load, the saving in power amounts to 660 − 596 = 64 horsepower.

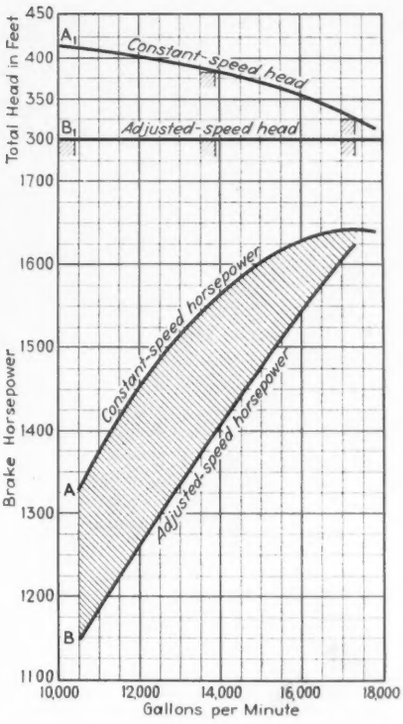


Fig. 4—Sectioned area shows power saved by adjusting pump speed over throttling the discharge

Variable-speed operation of boiler-feed pumps is desirable, not only from the standpoint of saving in power cost, but also because high excess pressures at light loads are avoided. In some cases the excess pressure with constant speed is such that heavier discharge piping, valves, fittings and heaters must be used. High and variable-excess pressure is also undesirable from the standpoint of feed regulation.

Excess Pressure

High excess pressures sometimes result from operating or starting the pump with low-temperature water, as well as from the natural shape of the constant-speed head-capacity curve. If a pump designed for a normal water temperature of 300 F is operated with cold water at constant speed, the total head will be increased almost 8%. Furthermore, the speed of an induction motor increases somewhat at light loads, resulting in additional increase of discharge pressure. Both of these conditions can be corrected by a variable-speed coupling.

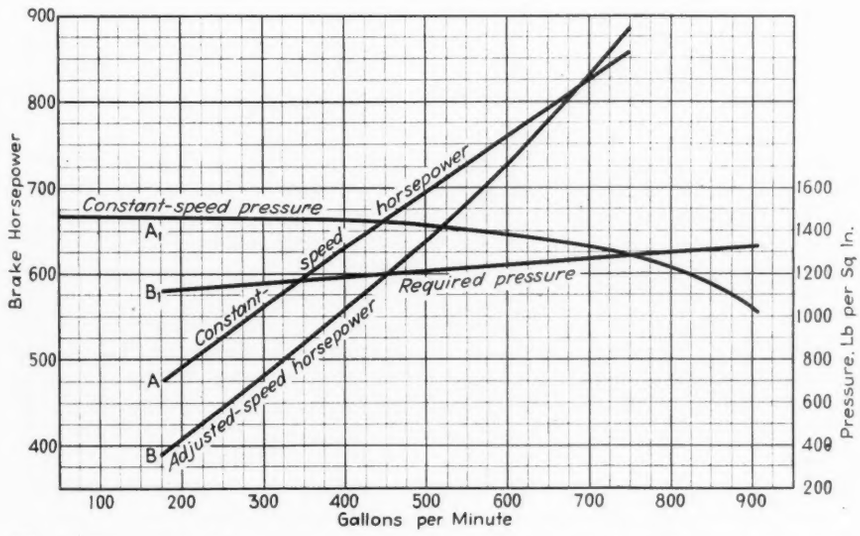


Fig. 3—Pressure and horsepower curves of a centrifugal boiler-feed pump driven at constant and at adjusted speed through a hydraulic coupling

Coal Handling at Bryce E Morrow

Belt and scraper-flight conveyors, in windowless, vacuum-cleaned galleries, handle 200 tons of coal per hour from track hopper to crusher plant and to boiler bunkers or storage yard

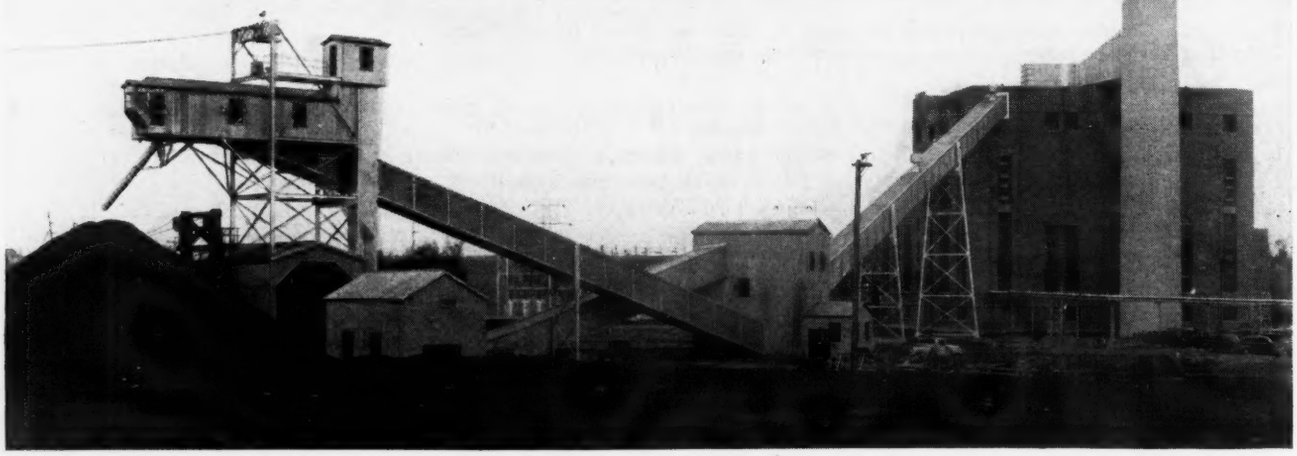


Fig. 1—Track hopper and storage yard at left, crusher plant in center towards power house

By H V SCHIEFER
Engineer, The C O Bartlett & Snow Co

▶ NEAR COMSTOCK, MICH., the Bryce E Morrow Station, completed late last year by Consumers Power Co, includes in its design a number of features which mark recent improvements in steam-electric-generating-plant development and operation. These have resulted in efficiencies scarcely deemed possible a few years ago. Among these features are the coal-handling facilities for receiving, unloading, storing and conveying the coal into the plant bunkers.

Designed primarily for efficient and economical fuel handling with a minimum of manual labor, the system of belt galleries and related structures also fits in with the architecture and landscaping of the plant and its surroundings, Fig. 1. Coal is received by rail and unloaded from standard-bottom dump cars into a steel track hopper, 18-ft wide by 38.5 ft long, provided with two outlets. The hopper sides slope at an angle of 50 deg with the horizontal. A steel grillage, with 14-in. square openings, covers the entire top area, serving both as a personal safety measure and as a screen to prevent large lumps or frozen coal from entering the system.

To protect workmen from the weather and to decrease the amount of wind-blown coal dust, the track-hopper is covered by a sheet-metal unloading house consisting of a roof and two sides. The coal-car unloading point and reserve ground storage coal pile are over 400 ft from the station and will be screened from view by carefully planned landscaping.

Coal is delivered from the track-hopper onto a 36-in. inclined belt conveyor by two belt feeders, Fig. 2, each having a capacity of 100 tons per hour, arranged for independent operation. This 36-in. belt carries the coal to the top of a crusher house where it is delivered over a magnetic pulley into a ring-roll crusher. From the crusher, which may be bypassed, coal goes onto either of two 30-in. inclined belt conveyors, depending on whether delivery is to the plant bunkers or to storage.

Dust-Tight Conveyors

The conveyor to the plant bunkers is about 325 ft long and elevates the coal to the top of the boiler room. A weightometer, installed at the lower end of this belt, automatically records weight of coal delivered to the bunkers. At the point where the belt enters the boiler house it passes through a metal partition, Fig. 3. Belt openings in this partition have as little clearance as is practicable, and are edged with flexible rubber strips. From this point on, the conveyors are inclosed in dust-tight casings. Since there is no partition between the bunker room and the boiler plant, coal dust leakage cannot be permitted.

A double-strand scraper flight conveyor receives the coal at the top of the boiler house from the inclosed belt and distributes it to the bunkers above the pulverizers. Steel-lined concrete bunkers have reinforced concrete floors, which support the distributor conveyor. The entire conveyor is inclosed in a dust-tight steel casing with the outlet gates operated by outside handwheels.

With ordinary inclosed bunker installations, air carried into the bunker with the coal, as well as air displaced by the coal, is forced out through small leaks in the casing. An exhauster system has been installed on this one, however, which maintains a slight suction on the bunker and conveyor casing that practically eliminates dust leakage. The exhauster discharges into a small cyclone separator which returns the coal dust to the bunker and discharges the air to the stack. Fig. 4 shows the conveyor and the exhauster system.

Coal for storage is diverted at the discharge of the crusher onto a 30-in. inclined belt conveyor discharging through a swivel spout onto the initial

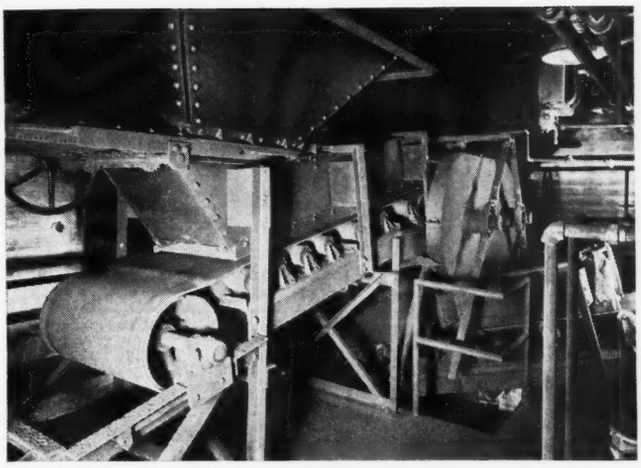


Fig. 2—Twin-belt feeders under track hoppers are both driven by one motor, but either can be declutched in an emergency

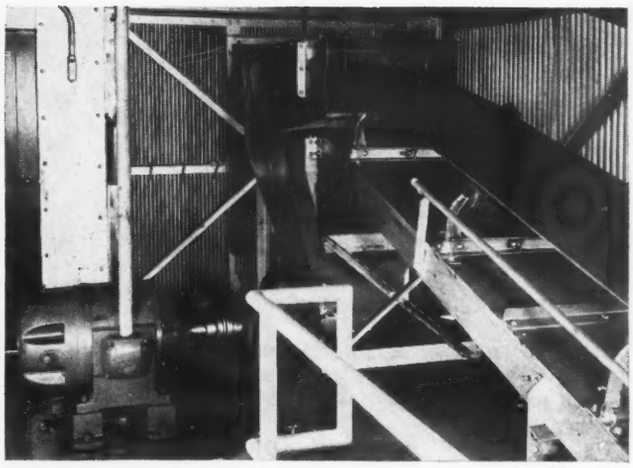


Fig. 3—Head ends of main belt conveyor, 325 ft in length, driven by motor through reducing gear and chain drive

coal-storage pile. The storage area, in the form of a semi-circle, has a uniform radius of 450 ft. Coal is handled in this area by a drag-line scraper system using an 8-cu-yd scraper bucket. This scraper operates in radial lines between a headpost and a self-propelled tail tower which travels on a track laid around the curved outside edge of the storage space, Fig. 1.

Drag-Scraper System

Operation of the drag-scraper system, including the movement of the tail tower, is by remote electric control located in a glass inclosure at the upper end of the storage belt conveyor. From there the operator can see the entire storage area. The tower gets its power through a cable hung from a messenger cable suspended between headpost and tail tower. Tension is maintained in the messenger cable by a counterweight at its head end.

When coal is being used from storage, it is brought to a steel reclaiming hopper beneath the swivel point at grade level. The bottom outlet of this hopper is fitted with a feeder that deposits the reclaimed coal onto the belt running from the car-unloading hopper to the crusher.

This entire coal-handling system provides for no spare or duplicate conveyors. Operation of the station requires that the coal-handling equipment be available for daily operation. To this end, incline of all belts has been kept at a maximum of 16.5 deg, all machinery made easily accessible, and only high-grade equipment used. Drives for all conveyors are inclosed, through herringbone-gear reducers, and all the belt idlers are roller bearing, 3-pulley design. Ample stairways and platforms give easy access to all machinery parts and the machinery house over the track hopper has a passenger elevator.

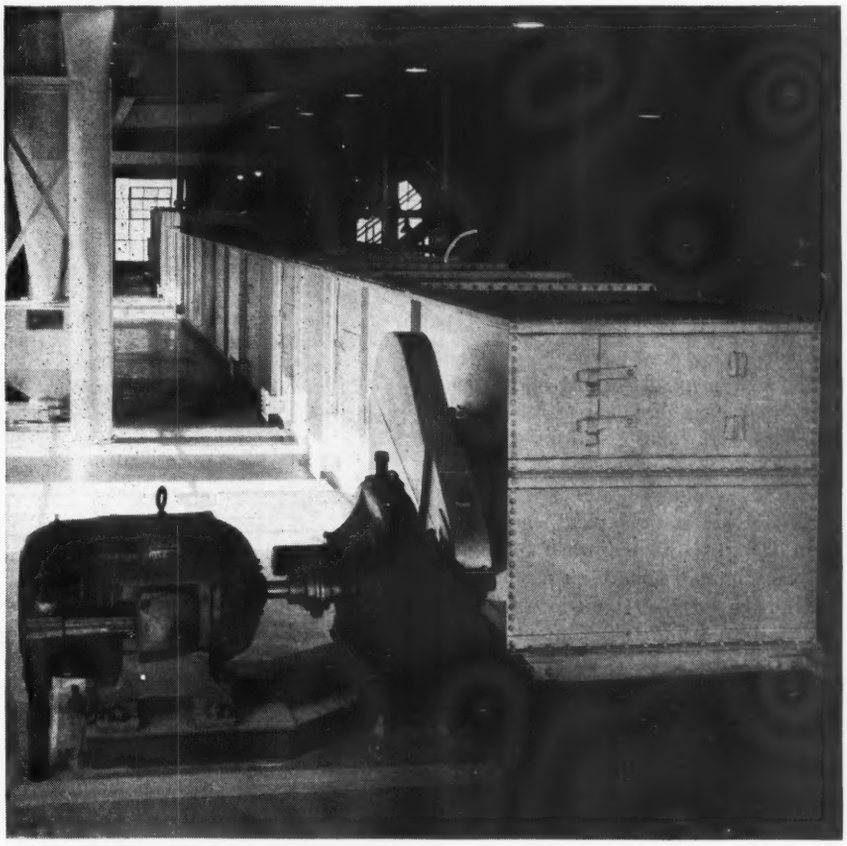


Fig. 4—Exhauster and cyclone on left take all coal dust from the totally enclosed flight conveyor and return it to the bunker

As a precaution against dust, the conveyor galleries have partitions which not only prevent natural draft but also confine any dust or dirt to a particular section. In addition, a vacuum-cleaning system extends to all parts of the coal-handling installation. The system has capacity to unload and handle 200 tons of coal per hour, which will take care of a substantial addition in plant capacity.

The conveyor galleries, machinery houses and unloading shed are covered with panels of corrugated, zinc-alloy sheet metal with the corrugations running parallel to the roofs of the conveyor galleries. As there are no windows in the conveyor galleries, artificial lighting is used. Zinc-alloy covering was employed because it is expected to have a long life, gives a pleasing appearance and reduces fire risk.

The conveying system with structures was supplied by the C O Bartlett & Snow Co, Cleveland, Ohio, supervised by Consumers Power Co engineers.

Sloane-Blabon Corp Cuts Plant Costs

Two-year record of modernized boiler plant surpasses expectations. R R Frederick, plant engineer, shows how it was done by burning low-cost coals on water-cooled stokers set in modern boilers

Power-wise R R Frederick, plant engineer of Sloane-Blabon Corp's Philadelphia outfit, has been in the game since graduation from Virginia Polytechnic Institute in 1925 with a B S in M E. Since then, he has been with American Can Co in Brooklyn, N. Y., and with Sloane-Blabon as asst plant engineer at the Trenton plant before taking over his present job in 1934

▶ EVERY POWER PLANT MODERNIZATION rests on some estimate of probable savings, and the extent to which these gains materialize measures the success of the program. By this standard, the boiler-plant changes at the Philadelphia plant of Sloane-Blabon Corp, makers of linoleum and felt-base floor coverings, proved their value, since savings in the first two years of operation exceeded predictions.

The new plant, described in POWER, July, 1938, was designed to burn non-premium, high-volatile, low-fusion slack coals. This made for definite savings over the medium-volatile run-of-mine coals used on the old plant, but these savings were increased when price-fixing was eliminated shortly after the new boilers went into service and we found coal delivered into the plant at prices we would not have dared to predict. Offsetting these unexpected gains were equally unexpected losses chargeable to the coal strike in the spring of 1939.

Careful Check Made

During the first 12 months of operation, results were carefully checked and compared item for item with costs and results that would have prevailed had the old boiler plant continued to operate. We were able to do this, and so accurately check performance and savings of the new units, because we had comprehensive records on the old boilers and equipment.

We found that, exclusive of interest, insurance, depreciation, taxes, and overhead, the savings accomplished by the new installation (boilers, draft equipment, water-cooled stokers, combustion control, coal-handling equipment and necessary meters and auxiliaries) ran as shown in Table I.

TABLE I—SAVINGS OVER OLD BOILER PLANT

Reduction in steam-plant fixed labor costs	34.5%
Reduction in coal-handling costs per ton	$.1247
Reduction in fuel cost at boilers, per M lb steam	$.1261
Reduction in maintenance cost (repairs and supplies)	41.5%
Reduction in total plant cost, per M lb steam	$.1501

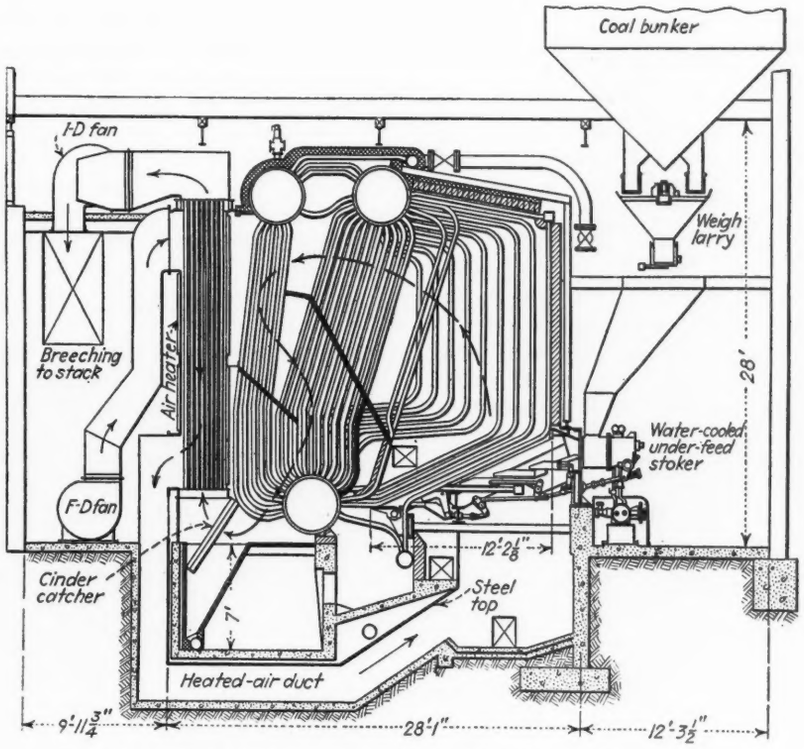
During the first year we burned considerable tonnage of low-volatile coal that, because of its low-fusion characteristics, was offered to us at an attractive price and came into our plant on the low freight rate. This coal worked to particular advantage on light summer loads but, for obvious reasons, proved less desirable for heavy loads than the high-volatile coal. Although we believe that the high volatile, low-fusion coals have, in general, proved most economical, tests run from time to time show the ability of our steam generators and firing equipment to handle coal with a wide range of characteristics:

Volatile	18–39%
Ash	6.3–12.8%
Sulphur	1.5–3.5%
Ash-fusion temp.	2100 F / 2600 F
Btu (as fired)	12,800 / 14,200

This fuel versatility enables us to take full advantage of market fluctuations.

We kept equally careful records during the second year of operation and these results are given later, in comparison with first year results. All these figures represent average annual operating results, as calculated from daily boiler-room log sheets and have not been taken from any short-run tests unless so stated. Before going into a comparison of these two years, we should look at several factors that affect the comparison. Thus, during 1938, practically all steam was

by $0.15 per M lb of Steam



One of two 3-drum, bent-tube, stoker-fired boilers at Sloane-Blabon

made from coal and the standby boiler, fired by a Riley stoker, made about 9% of the total. In 1939, the standby boiler was oil-fired and about 3.3% of the total steam came from this fuel. Furthermore, we produced about 5.5% more steam in 1939 than in 1938.

Biggest differences between the two years can be charged to the coal strike in 1939. Thus, in 1938, coal prices, quality, and handling cost were relatively stable. For protection against lack of coal due to the 1939 strike, we installed two oil burners in the front wall of the standby boiler and covered the Riley stoker with fire brick. This quick and economical change gave us the needed protection. To stave off as far as possible the depletion of our bituminous coal stock, we burned considerable quantities of anthracite, mixed in proportions up to 50% with our bituminous coal. This required careful handling on the stokers so as not to lose the fire but we succeeded in burning it and keeping the plant running. During this period, evaporation fell off about 20% and we estimate that the additional tonnage required increased one month's coal cost by about $720.

Not only did coal cost go up, handling cost went up likewise because of the extra labor involved in mixing the anthracite and bituminous on the pile and the final depleting and restocking of our coal-storage pile. As our coal contract expired about the time of the strike, our fuel costs went up afterwards because of the rising market that followed. Thus cost per million Btu increased over 1938 although we were able to hold this down by buying lower-grade coals when the price was right. The net result of all these factors was a small increase in cost per ton but, since we realized fewer Btu per ton, there was a somewhat larger increase in cost per million Btu.

Operating Results

Table II compares results in 1938 and 1939 on several different bases. In spite of the cost increases in the second year of operation, largely due to the circumstances outlined above, the savings from the new steam plant are in line with preliminary expectations.

Average annual over-all efficiency on

TABLE II — OPERATING RESULTS IN 1938 AND 1939

	1938	*1939*
Cost of fuel delivered into the plant, per million Btu	$.1346	$.1432
(including cost of all oil burned during 1939)		$.1449
Coal-handling labor, within plant, per million Btu	$.00326	$.004425
Power consumption for coal handling:		
Cars to pile and/or to coal hopper, kwhr per million Btu	0.0215	0.0335
Power consumption, all other purposes, kwhr per million Btu	0.483	0.4925
Total cost of repair materials for boiler-house and coal-handling equipment, per million Btu	$.00966	.0108
Total[1] of all costs except fuel, per million Btu	$.0702	.0786
Total[1] of all boiler-house costs, per million Btu	$.2048	$.2235
Total maintenance and repair costs per ton of coal	$.2735	$.2793*
Total steam-plant operating costs per ton of coal	$5.80	$6.08*
Reduction[2] in fuel cost at boilers, per M lb of steam	$.1261	$.1073
Reduction[2] in total steam-plant operating costs, per M lb	$.1501	$.1221

[1]Fuel costs ran about 2/3 of total operating costs for the two-year period.

[2]Determined by comparison with what costs would have been had old equipment handled existing loads.

None of above costs include interest, insurance, taxes, depreciation, etc. Up until the beginning of the second year of operation, ash was hauled away free of charge, but during 1939 a contractor paid a fair sum for exclusive rights to the stoker ash. This agreement has been renewed for the current year.

* *Includes both coal and oil.*

the new boilers ran 83.5% in 1938 and 79.1% in 1939. Undoubtedly the effect of burning a mixture during the strike period and the difficulty of determining the extent to which this mixing lowered the heating value of the final coal mix, make this latter figure somewhat inaccurate. Average temperature of flue gas leaving air heater, for a two-week test period, was 337–393 F or 244 F above room temperature. Tests show the following heat balance:

Gas and vapor loss	10.84%
Unburned combustible	1.00%
Radiation and unacctd	2.00%
Total losses	13.84%
Efficiency	86.16%

Based on the average yearly efficiency during 1938, we estimate the following average heat balance:

Gas and vapor loss	12.0%
Unburned combustible	1.5%
Radiation and unacctd	3.0%
Total losses	16.5%
Efficiency	83.5%

During the first two years of operation, we have tested some 18 different slack coals, both high and low volatile, but practically all of the low-fusion type. These tests are, of course, subject to slight inaccuracies likely to occur in short-run tests using regular plant instruments. However, the accumulated data gives us a reliable check on the *relative* values of coals tested, in terms of performance on *our* equipment.

Test Constants

We convert actual evaporation, as obtained on the test, to equivalent evaporation to reduce each test to standard conditions and to treat each coal as fairly as possible. We furnish the Purchasing Dept with a "test constant" for each coal. This constant, when multiplied by the delivered cost, shows the cost of producing M lb of steam with that particular coal. This enables the purchasing dept to appraise intelligently the coal values. If the margin of choice is slight, the Purchasing Dept consults the Engineering Dept and we review the complete test data, giving weight to such factors as ash, sulphur, moisture content, clinkering tendencies, probable delivered Btu per lb, etc.

Coal selection is an intricate problem at best, but by following the above procedure, we have actually obtained gratifying savings and have debunked the pet sales argument that the most expensive coal is the cheapest in the long run. Our plant was designed to burn non-premium coals, so that our primary concern is to get lowest cost per M lb of steam, assuming the coals considered possess no outstanding objectionable characteristics. Buying on this basis, the purchasing agent can take advantage of low markets and make spot purchases from time to time. After a goodly number of coals have been tested, there is plenty of competition and attractive prices result.

SCALE can usually be removed from the water jackets of diesel engines by boiling out with a 10–20% solution of muriatic acid, although in some cases a stronger solution may be required. To protect steel parts from acid corrosion, the jackets should be thoroughly flushed out after the boiling process.—THE LOCOMOTIVE.

✦ ✦ ✦

Gas Welding Carbon-Moly Pipe

Laboratory-developed procedures and field checking have led to these practical specifications for proper oxy-acetylene welding of high-pressure, high-temperature piping*

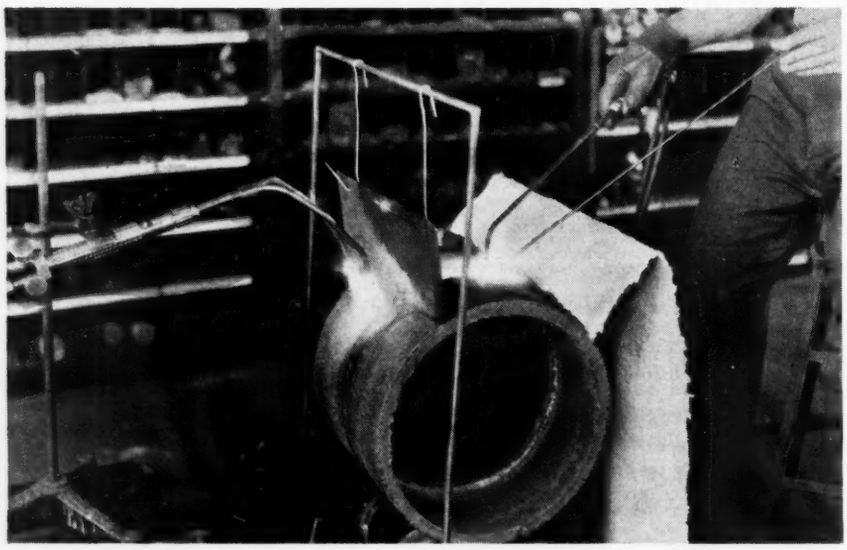


Fig. 1—Continuous preheat of a roll weld in shop. Position welds were also produced, methods of preheat developed, stress relief by torch heating investigated

▶ TO OBTAIN OXY-ACETYLENE WELDS in carbon-moly pipe that will conform to ASA and ASME code requirements, it is necessary (1) to use a suitable welding rod, (2) to employ the multi-layer method of welding, and (3) normalize after welding.

Gas welding requires no chipping, peening or backing rings. A certain amount of preheat is inherent in using the torch. Chipping is unnecessary because the oxides do not interfere with deposition of the subsequent layers of metal. Peening, usual with arc welding to reduce shrinkage stresses set up by steep temperature gradients in cooling, can be eliminated because the gas weld introduces only gradual temperature gradients.

In a gas weld, the first bead of a butt joint can be made with full penetration without backing rings. One

* Laboratory investigation reported by R M Rooke, Air Reduction Sales Co, and F C Saake, Instructor in Metallurgy, Polytechnic Institute of Brooklyn; field work discussed by A. N. Kugler, Air Reduction Sales Co, at 40th Annual Convention of International Acetylene Association, April, 1940.

fabricator reports laying the first layer of an arc weld by the oxy-acetylene process to avoid using a backing ring.

The proper application of oxy-acetylene welding to carbon-moly steel requires a knowledge of the three variables already mentioned, namely the proper rod, the welding method and the heat treatment. With control of these factors, gas welding is quite capable of producing strong, sound weld metal of high strength and ductility and of an analysis similar to the base metal.

Preheating

All pipe of 5/8-in. wall thickness or heavier should be preheated by electrical means or by the torch so that both sides of the beveled edge are heated through the entire thickness of the pipe. It is also possible for the operator to apply preheat intermittently with the welding torch, alternating preheat with deposition of metal.

Edge bevel between 30 and 45 degrees (37½ deg is preferred), as shown in Fig. 3, and spacing of pipe ends about 3/16 to ¼ in. are preliminaries to the multi-layer technique, Fig. 4, for wall thickness over 3/8 in. One layer of deposited metal is used for each 5/32

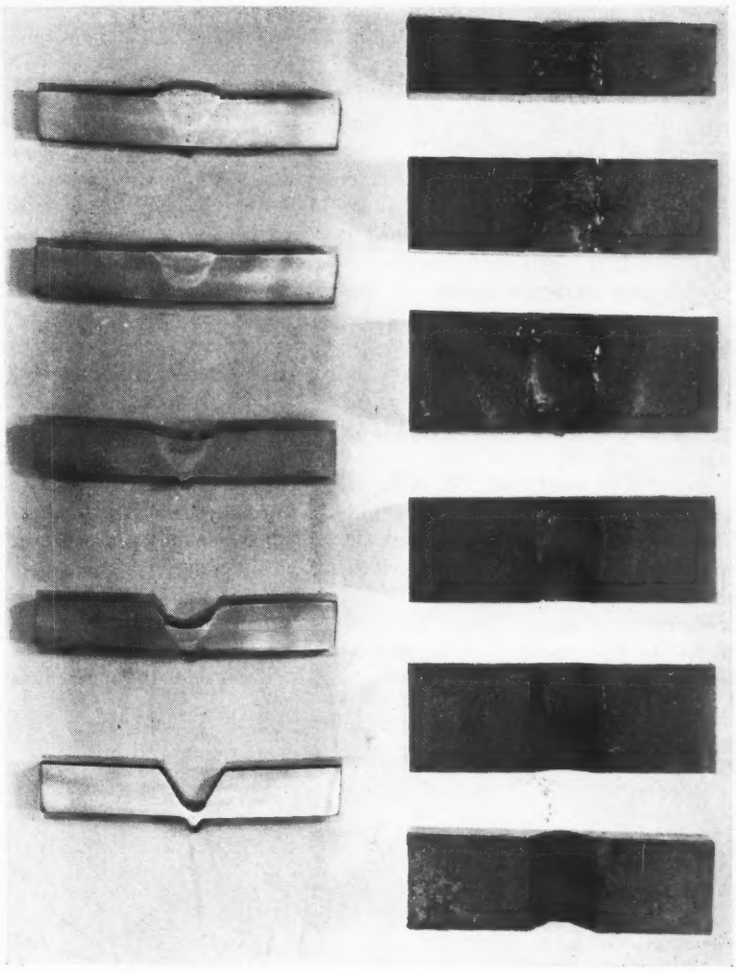


Fig. 2—Step-by-step sections of multi-layer weld in heavy-wall pipe

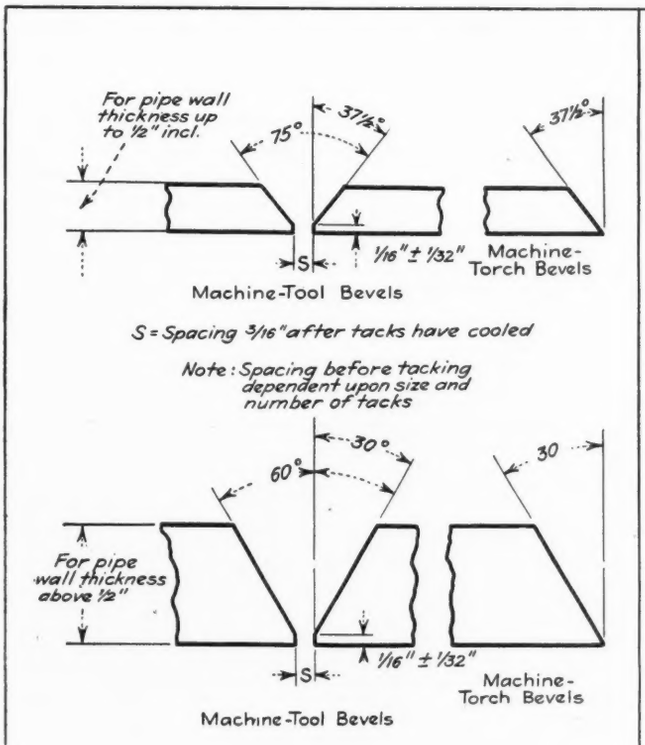
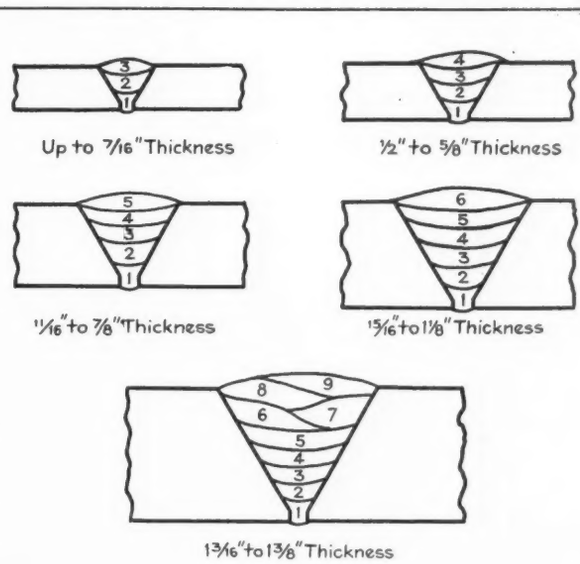


FIG. 3



Wall Thickness	Roll Welds									Position Welds	
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	1st	Others
7/16"	1/8"	3/16"	1/4"							1/8"	3/16"
5/8"	1/8"	3/16"	3/16"	1/4"						1/8"	3/16"
7/8"	1/8"	3/16"	3/16"	3/16"	1/4"					1/8"	3/16"
1 1/8"	1/8"	3/16"	3/16"	3/16"	1/4"	1/4"				1/8"	3/16"
1 3/8"	1/8"	3/16"	3/16"	3/16"	1/4"	1/4"	1/4"	1/4"	1/4"	1/8"	3/16"

FIG. 4

Fig. 3—Machine-tool and flame-cut bevels for gas welding.

Fig. 4—How to lay-in the separate beads and table of rod sizes

in. of wall thickness. Use 1/8- to 3/16-in. rod for the first two layers of multi-layer welds.

After the welding is completed, the entire joint should be heated to a temperature of about 1500-1600 F. This can be done by starting at the end of the last layer of weld metal and reheating the face of the weld until it shows red in a continuous circumferential traverse with the torch. If this procedure is employed for normalizing, the entire circumference should be again brought up to dull red with the torch for stress relieving, and cooling should be slow, such as would take place in still air, or the joint can be wrapped with insulation. If, however, normalizing is done by reheating uniformly, for example by electric methods, and a slow rate of cooling is provided, no further stress relieving is needed.

Experiments with welding rod started on the assumption that the molybdenum content of the weld metal should be not less than 0.45%. The recommended welding rods for this class of work carry sufficient of the metal to assure this minimum. With a pipe molybdenum content of 0.52% in the experimental work, and a rod content of 0.43%, the weld metal was found to contain 0.48%, indicating practically no loss of molybdenum during welding. The welding rods were calculated to give weld metal of nearly the same analysis as the base metal with slight modifications to improve weldability.

Improvement in weld quality at slightly lowered welding speeds can be obtained by decreasing the nominal thickness of each layer from the previously recommended 1/4 in. to 5/32 in. The inclusion of continuous or intermittent preheat in the welding procedure further improves weld quality.

Continuous preheat allows the welding to proceed steadily except to change rods. The use of a torch-normalizing treatment after welding is an economical method of heat treating weld metal to obtain increased ductility.

It is general practice among many qualified operators in welding pressure vessels to use a flame showing a short feather of acetylene. Fluctuations in the gas ratio during welding may leave sections of carburized weld metal that would show poor ductility in the as-welded condition. The normalizing treatment is therefore doubly important.

Data collected by a large eastern utility on the welding of heavy-wall carbon-steel pipe indicates that oxy-acetylene welding is performed in one-third to one-half the time required by other standard procedures. The greater difference in production occurs, in general, in the small sizes and lighter weights. Lesser differences appear for larger sizes.

Because of the inherent advantage in time saving, present also in welding carbon-moly pipe, field tests have been made in over twenty locations including fabricating shops, utility stations and industrial power plants. Only minor modifications to the procedure already described have been necessary to adapt the methods to field conditions. The first laboratory welding was done in the equivalent of "rolling" conditions; field welding was done in fixed-horizontal and fixed-vertical position as well. Results can therefore be taken as representative of actual construction.

On rolling welds it has been found acceptable to employ layers as thick as 3/16 in. On position welds, however, under adverse conditions, continuously deposited 5/32-in. layers are preferable.

Concerning rod size, the first layer of rolling welds should be made with 1/8-in. rod and intermediate layers up to 3/4-in. thickness, with 3/16-in. rods. Intermediate layers above 3/4-in. thickness should be made with 1/4-in. rod. For position welds, the first layer is made with 1/8-in. rod and all succeeding layers with 3/16-in. rod.

Separate preheating for carbon-moly piping is not absolutely necessary. The inherent preheating effect of the flame has been found entirely adequate for the majority of joints to date. In the heavier wall thicknesses, it sometimes proves advantageous to preheat and weld alternately with the torch, a procedure already described.

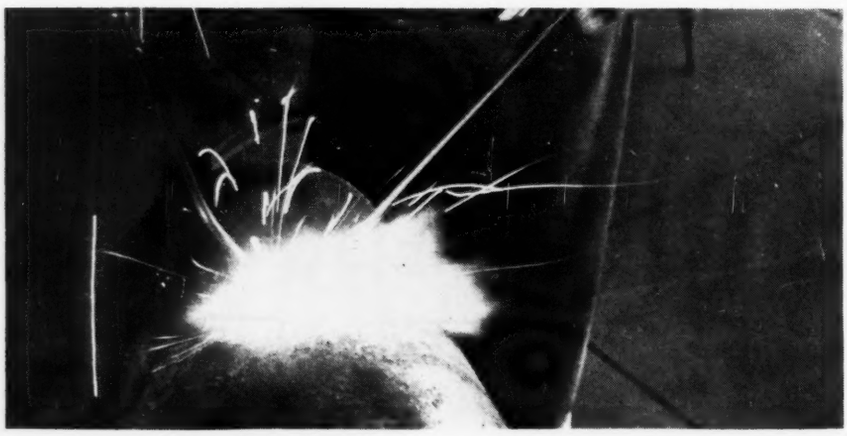


Fig. 5—Position of torch and rod for roll weld

Field Checking

One small piping system in the middle west for 1800-lb, 900-F heater supply has been completed. Pipe is heavy-wall in sizes from 2 to 4 in. The work was performed under the usual field difficulties and involved all the usual types of joints. Stress relieving was accomplished by heating the joints with the torch to 1400-1450 F and immediately wrapping the joint with asbestos blanket or paper and plugging open ends. Stress-relieving temperature was checked by a pyrometer.

This project was installed by regular employes of the owner and no attempt was made to rush the job. In view of this condition, production data are of interest:

3-in. position weld—50 min plus 5 min*
3-in. rolling weld—40 min plus 5 min
2-in. position weld—40 min plus 4 min
2-in. rolling weld—30 min plus 3 min

* *for stress relief*

Daily production averaged eight 3-in. or ten 2-in. welds. No leaks or failures have developed after a year's operation.

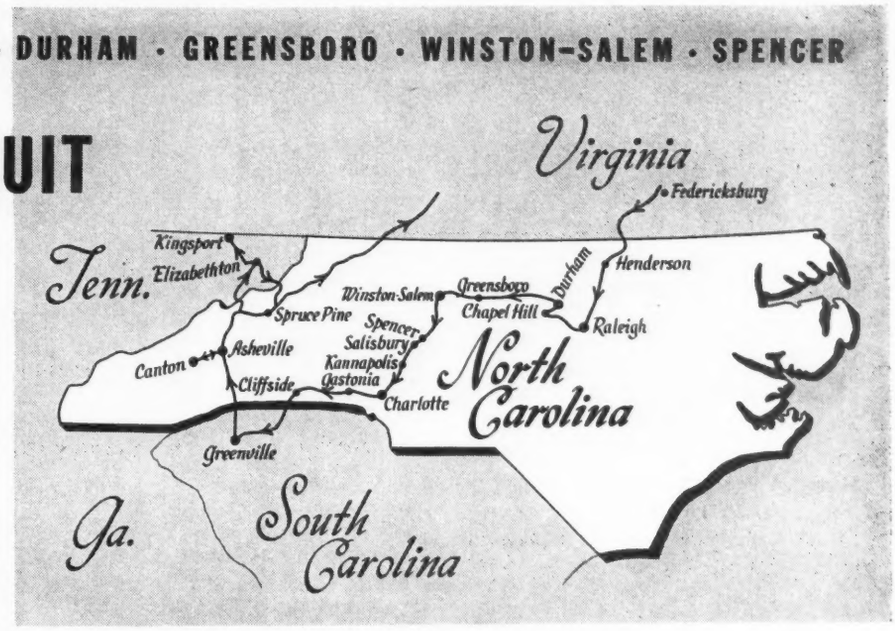
Additional data, although admittedly incomplete, includes an 8-in., 0.625-in.-wall roll-welded joint finished in 1½ hours and stress relieved in 17 minutes with two torches. This joint required 80 cu ft of oxygen, 70 cu ft of acetylene and 2.75 lb of rod. Post heating consumed 45 cu ft of oxygen and 38 cu ft of acetylene.

Other reported data include 2¼ hours for welding 10⅝-in. by 0.718-wall pipe and 3 hours for 14-in. by 0.75-wall pipe. It is recognized that this information is insufficient for estimating purposes.

On the basis of this work, we can now recommend the oxy-acetylene welding of carbon-moly steel pipe in any of the sizes and weights currently employed in power-plant practice. The requisites are: welding rod of carbon-moly analysis designed for oxy-acetylene welding, the use of the multi-layer technique, and stress relief by any one of the several methods indicated.

I—RALEIGH · CHAPEL HILL · DURHAM · GREENSBORO · WINSTON-SALEM · SPENCER

CAROLINA CIRCUIT



Editor Philip Swain reports his engineering rambles through a land where engineers operate great central stations, cotton mills, rayon, paper and chemical plants in a setting of green trees, bright flowers and friendly mountains. To be continued

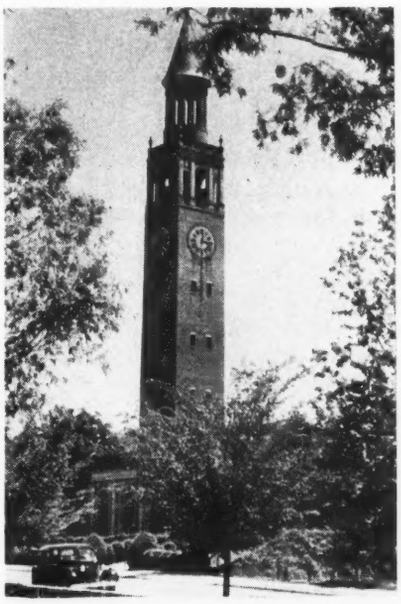
▶ THE EDITORS OF POWER spend a lot of time in the field. To misquote the old hymn, "New York is our resting place, America is our home." Slightly inaccurate, of course, because New York is no "resting place." It is, however, the base of operations—the place where we stew over the findings of the last trip before we start on the next.

Most of these journeys find their way into print bit by bit, as articles or items on specific plants, but now and then we come back so impressed with the character of a whole region that a "travelog" seems in order to give the reader something of the "feel" of an actual journey without forcing him to spend the money or take the time to go there in person. Such was the serialized report of my engineering tour of seven European countries in 1936, and of my West Coast tour last summer.

This month and next I shall attempt to give readers my fleeting impression of a three weeks' editorial trip devoted mainly to North Carolina, but touching also Virginia, South Carolina and Tennessee. It might be called a follow-up of a southern trip I took in 1935, when I put my car on the boat to Charleston and drove north from there by a very zigzag path.

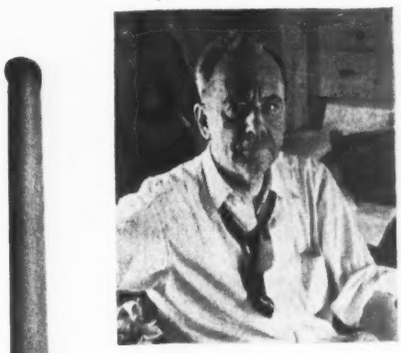
This time I made the entire circuit by automobile, taking the wife along as relief driver and chaperon. Baggage included typewriter, Leica camera and a complete 5x7 view-camera outfit for plant stories. Editorial stops are charted on the map above.

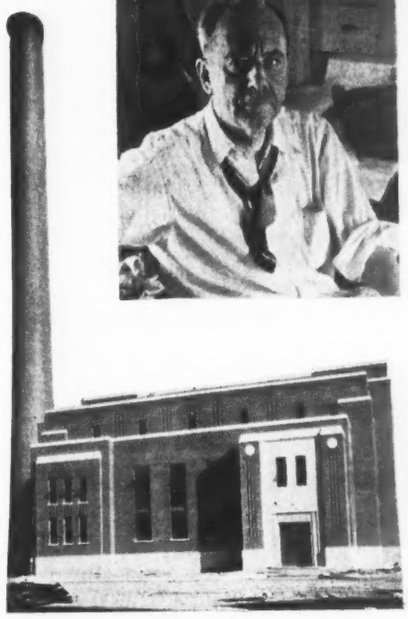
Stopping at Fredericksburg, Va., on the way down via U. S. highway No. 1, I visited the Sylvania Industrial Corporation and was shown around by E W Cornwell, chief engineer, who took me through the power house. Sylvania (sheet-cellophane plant) is typical of several southern process plants I shall mention in these rambles. It is a large establishment, beautifully laid out, equipped with the most modern machinery, set in a background of green forest and hills that would do justice to the finest northern country club. Steam is generated at 420 lb and 100 deg superheat in four boilers—two 30,000-lb-per-hr Combustion Engineering units



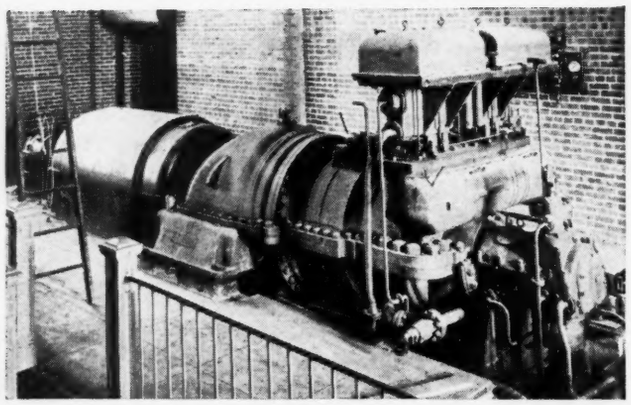
Stately tower dominates campus of University of North Carolina at Chapel Hill

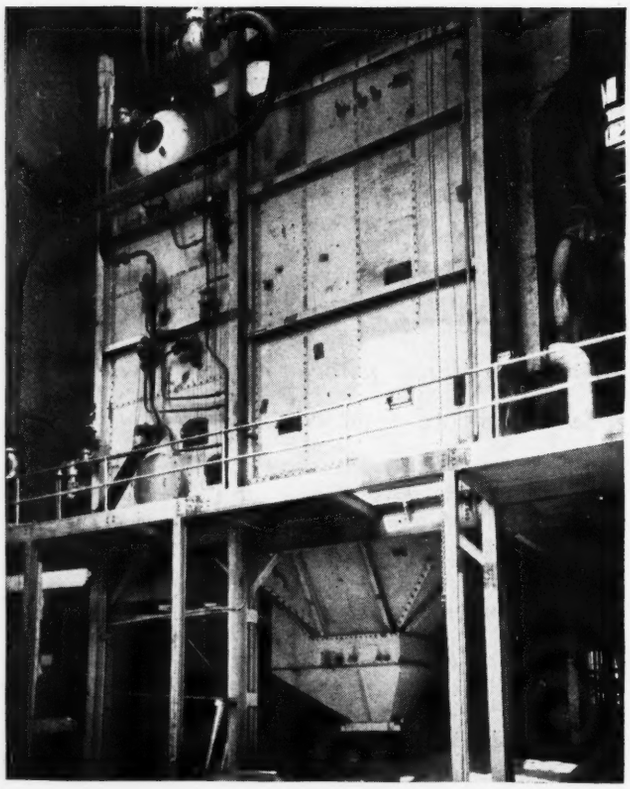
Professor and Mrs Robert B Rice (North Carolina State College) at home on White Oak Road in Raleigh





New power plant of University of North Carolina nearing completion. Plant is connected to University by 3200-ft "walk-through" tunnel. Above, resident engineer A D Schofield





Above—2500-kw condensing turbine extracts for heating at 75 and 25 lb at University of North Carolina power plant. Right—One of two 70,000-lb-per-hr boilers (450 lb and 750 F)

with Frederick stokers, one 60,000-lb Henry Vogt unit with Westinghouse stoker, one 60,000-lb Edge Moor unit with Westinghouse stoker. At the time of my visit heavy steel work was going in for a boiler-room extension.

When Sylvania was first built about 10 years ago, byproduct power was generated in two straight back-pressure turbines exhausting at 60 lb g. These had a combined capacity of about 3000 kw. The remaining power demand was purchased.

About two years ago they put in a 2500-kw condensing unit, bleeding to process at 60 lb. Since then no power has been purchased. As in many plants of this general type, the heat balance is extremely good and very little steam goes to the condenser.

Mr Cornwell meters electricity and process steam separately to each consuming department. He considers this essential to economy.

Raleigh

Next editorial stop was in the fine southern city of Raleigh, capital of North Carolina. Over the week end, until Tuesday morning, Mrs. Swain and I were guests of Professor and Mrs Robert B Rice who live out on the tree-clad hills of White Oak Road. Professor Rice teaches Experimental Engineering at the State College of North Carolina.

On Monday, May 6, after attending a very well-patronized luncheon of Raleigh's flourishing Lions Club, I spent the afternoon going through the engineering buildings of North Carolina State College. Had a fine session with Prof. L L Vaughan, chairman of the ME Dept. Also had a very pleasant session with Fred B Wheeler, Professor of Mechanics and superintendent of all shops—incidentally a solid citizen, intensely practical and a natural teacher.

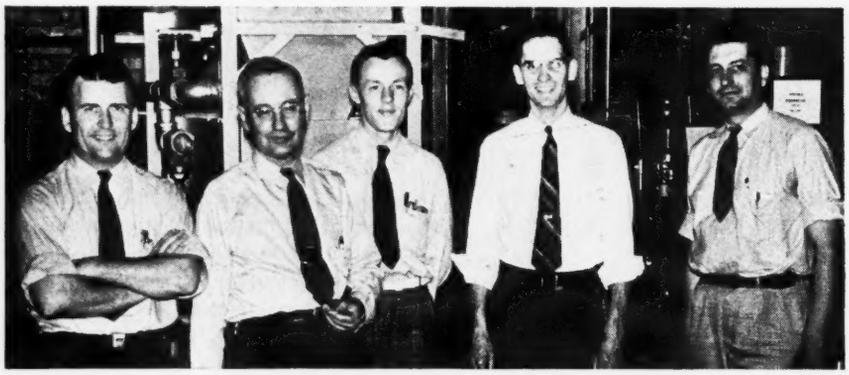
Professor Vaughan took me over to the college power plant, where I met the genial chief engineer, A A Riddle. As I recall, this plant has stoker-fired boilers and a 2500-kw Elliott turbine.

Monday evening I addressed the dinner meeting of the Raleigh Engineers Club. They met in the parish hall of a local church—good dinner and fine bunch of men, practically all of old American stock.

Before leaving Raleigh on Tuesday morning, May 7, I visited Mr Yoder, assistant to the president of Carolina Power & Light Co. Carolina P & L gets most of its energy from hydro, but has had to draw on some of its old steam plants in recent months. This utility has plants around Raleigh, also some in the western part of the state. Its Waterville hydro plant, up in the mountains west of Asheville, has the highest head (861 ft actual, 755 ft effective), of any plant east of the Rockies. This 108,000-kw installation includes a horseshoe-section tunnel 6 miles long and 14 ft in diameter. Carolina Power & Light has arrangements for power interchange with the Duke Power Co and the Appalachian Electric Power Co.

Leaving Raleigh, we drove over to Chapel Hill. Seat of the University of North Carolina (not to be confused with North Carolina State College), Chapel Hill, is an old ivy-clad college town of wonderful charm. The U of N. C., one of the best known in the South, had its own engineering school a few years ago, but this has now been merged with that of State College in Raleigh.

At the old power-house on the campus I stopped to chat with POWER subscriber T C Murray, chief operating engineer. Chief Murray told me that he had "gone back to school again," was taking the Hays correspondence course in combustion. His last paper was



Mechanical engineering staff of Duke University, left to right: Prof F J Reed (air conditioning), Prof R S Wilbur (department head), L C Pipage (industrial and drawing), R G Chapman (machine design and aeronautics), E S Theiss (heat power)

graded 97; must be the college atmosphere of Chapel Hill.

Following this, I talked with two other readers, J S Bennett, superintendent of all utilities for the University, and H E Thompson, superintendent of engineering. Next, I drove out about a half mile to the new University power plant, now nearing completion. A D Schofield, resident engineer, showed me around.

Designed by Wm C Olsen, consulting engineer (Raleigh), this plant is a fine-looking job with first-class equipment. It is being built with a PWA grant and should be in operation before the fall term of college starts. Equipment includes two 70,000-lb-per-hr Combustion Engineering bent-tube boilers designed for 450 lb pressure and 750 F. The 2500-kw Elliott condensing unit bleeds (for campus heating) at 75 lb and 25 lb. Circulating water is cooled by a big concrete-lined spray pond. Furnace air is preheated by two Ljungstrom air preheaters with turbine-driven fans.

The new plant is connected with the University and the old power plant by a 3200-ft "walk-through" pipe tunnel 6½ ft high and 7 ft wide. The University will have Duke Power for standby.

Durham and Duke

From Chapel Hill it was only a short run to the Hotel Washington Duke in Durham, famous tobacco processing city. Big stacks and water tanks, labeled "Lucky Strike" and "Bull Durham" could be seen from my hotel window. On Wednesday morning, May 8, I visited the power plant of the American Tobacco Co and had a lively session with chief engineer P Pederson.

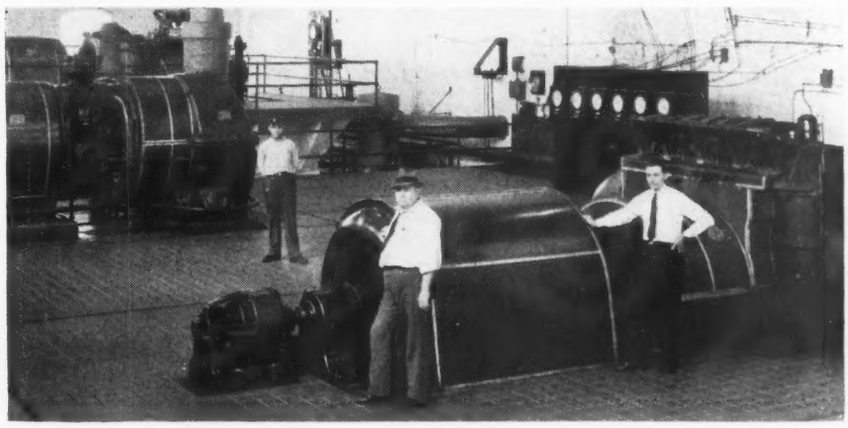
After lunch Mrs Swain and I drove out to nearby Duke University. This is the wealthiest university in the South and one of the wealthiest in the United States, with a total endowment well over $40,000,000 and still growing.

About two miles away is the Women's College of Duke University, with many more fine buildings. Tucked away in the far corner of this campus is the School of Engineering.

We were greeted by the entire faculty of mechanical engineering: Prof Ralph S. Wilbur (department head), Asst Prof F J Reed, Robert G Chapman, L C Pipage, E S Theiss. Professor Wilbur, who showed me all over his new mechanical laboratory, was formerly a civilian teacher at the Naval Academy. He was born in Massachusetts.

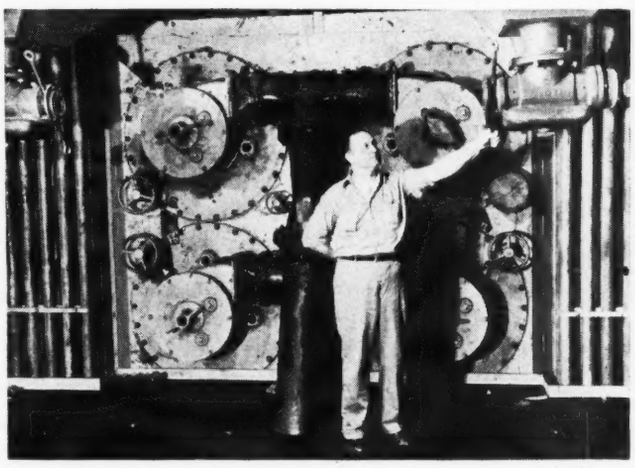
Outside the Mechanical Engineering Dept, I talked with Dean William H Hall and Prof Walter J Seeley, head of the E E Dept.

Next visit (May 9) was to Proximity Mfg Co in Greensboro. There I met C E Kerchner (superintendent of power), W B Burke (assistant superintendent of power), T G Haithcock (boiler-room foreman), W M Smith turbine operator), Robert Tucker (boiler operator) and V O Watson (water tender). The power-house, in the White Oak Mills of Proximity Mfg Co, supplies both steam and electricity to White Oak Mills, Proximity Print Works, and Revolution Cotton Mill. White Oak is a denim mill with 3139 looms, most in the world on one floor.



Turbine room at Proximity Mfg Co, left to right: L B Hipp (turbine operator), W B Burke (asst supt of power), C E Kerchner (supt of power)

Boiler-room force at Proximity, left to right: Robert Tucker (boiler operator), T G Haithcock (boiler-room foreman), V O Watson (water tender)



Boiler-room foreman T G Haithcock displays new 150,000-lb-per-hr steam-generating unit at Proximity Mfg Co

Three big boilers installed about 1928 (and described at that time in POWER) generate steam at 450 lb and 650 F. Two are Combustion Engineering units and one B & W. All are pulverized coal-fired, and each boiler generates 90,000 lb per hour of steam. The three steam turbines are large for an industrial plant. I am sorry

(Continued on page 124)

Compressed Air Interrupts High-Voltage

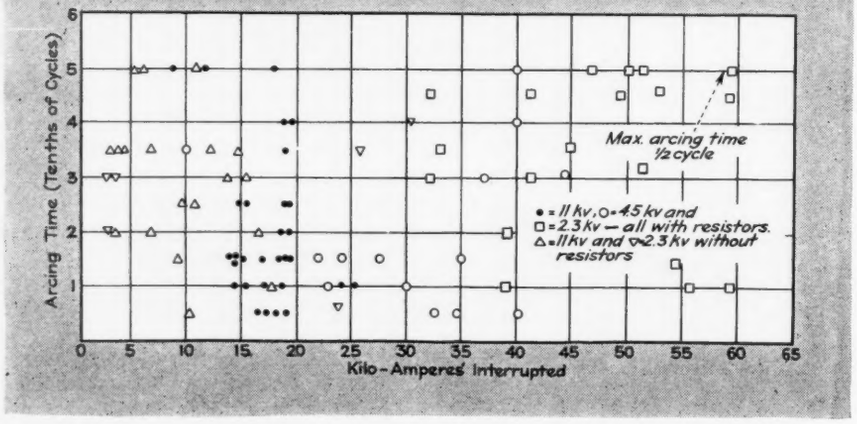

Arcing Time (Tenths of Cycles)
Kilo-Amperes Interrupted
Max. arcing time ½ cycle
• = 11 kv, ○ = 4.5 kv and
□ = 2.3 kv — all with resistors.
△ = 11 kv and ▽ = 2.3 kv without resistors

Fig. 1—Typical test interrupting arcing times for axial air-blast circuit breakers

Information on just what an axial air-blast circuit breaker is, how it operates and interrupts heavy currents at high voltages, explained by Harold W Martin, Allis-Chalmers Mfg Co

► DEVELOPMENT of air-blast circuit breakers is a result of the growing demand for the elimination of oil in electrical power apparatus. Much research has been directed toward producing a satisfactory oilless circuit breaker, capable of application over approximately the same ranges of current, voltage and interrupting capacity as the oil circuit breaker, both indoor and outdoor. Air-blast circuit breakers have resulted which, by using the prestored energy of compressed air for circuit interruption and for opening and closing, produce such a high order of interrupting efficiency that arcing times of one-half cycle or less are consistently obtained.

Automatic Resistors

Another factor contributing to the interrupting efficiency of axial air-blast circuit breakers is the design, which readily permits the incorporation of resistors. These, automatically connected into the circuit by action of the interrupting arc, limit the magnitude and rate of rise of recovery voltage during the arc-interrupting process.

Fig. 1 shows the arcing times obtained during a series of interrupting tests made on a 1200-amp, 15-kv, 500,000-kva-interrupting-capacity, axial air-blast circuit breaker of the type shown in Fig. 2. Results are plotted for tests made with and without resistors at 11, 4.5 and 2.3 kv. In all cases the arc was interrupted in 0.5 cycles or less.

The breaker (Fig. 2) is assembled on a horizontal compressed-air tank T forming the foundation on which the active parts of the breaker are mounted. Air for operating the breaker and for interrupting the arcs is stored in the tank at 200 lb g, the tank being permanently connected to a compressed-air storage system. The arcing-contact chamber A, and the cooling chamber and muffler M, are supported on the air tank by hollow insulators I.

Fig. 3 shows a diagrammatic cross-section of an axial air-blast circuit breaker with all parts in the closed position. The electrical circuit is through arcing-contact chamber casing A to movable arcing contact C, isolating-contact member D and out of the breaker at 0, as indicated. Main blast valve V is located in the air tank and held closed by spring S under piston P, and by pressure of the air in the tank.

Operating valve V_1 may be actuated manually or electrically. When this valve is opened, air pressure is admitted above piston P which is forced downward and opens main blast valve V, admitting air into arcing-contact chamber A, as shown in Fig. 4. When air pressure in arcing-contact chamber reaches a value sufficient for efficient arc interruption, piston P_1 is forced downward against the upward pressure of spring S_1 and pulls movable arcing contact C away from the stationary contact and air-blast orifice C_1. This draws an arc between the points marked initial arc.

Because the orifice in the center of the stationary contact is the only outlet for the air, a blast of high-velocity compressed air discharges across the initial arcing zone and through the orifice to the interrupting chamber and muffler. The air blast through the orifice acts to centralize and extend the arc until it comes into contact with electrode E, as shown. This controls the length of the arc and helps to limit the arc energy released. The air blast also quickly forces the arc products and any ionized gas into the cooling chamber and muffler, thus rapidly scavenging and deionizing the arc path during current zero.

Cooling Effect of Air

The rapid expansion of the air as it enters the arc-interrupting chamber causes an intense cooling of the arc. This cooling effect acts to deionize the arc and limits its current conducting ability by reducing its cross-section, particularly as the current approaches zero.

When the arc goes out, at or near current zero, the air blast immediately sweeps away the arc products, so that any restriking of the arc tends to take place between the points marked initial arc, where the air is still substantially under compression. As the dielectric strength of the air between these points is approximately equivalent to that of oil, and as this compressed air is passing at high velocity between the contacts, a comparatively short contact separation is sufficient to prevent restriking of the arc after the first current zero.

Simultaneously with admission of air to the arc-interrupting chambers, a small port permits air pressure to build up above piston P_2. The build up of air pressure is so regulated that piston

Circuits

P_2 will be forced downward and open the isolating contact D under no load, as soon as arc interruption is completed, as shown in Fig. 5.

Immediately after the isolating contacts open, an auxiliary contact interrupts the circuit controlling auxiliary valve V_1, and this valve closes. This cuts off the air supply to the main-valve piston P and permits air above the piston to escape. Main valve V is then closed by spring S and the air pressure remaining in the tank; air pressure in the contact chamber falls and arcing contact C is closed by spring S_1.

Air required for arc interruption causes a decrease of pressure in the breaker air tank. Since the tank is permanently connected to a compressed-air storage system the supply within the tank is quickly replenished.

Where high rates of recovery voltage are expected, the breaker is usually equipped with resistors, non-inductively wound around the outside of the mufflers and protected by outer insulating tubes. Figs. 3 to 5 show one of these resistors diagrammatically. Referring to Fig. 4, when the air blast extends the arc into contact with electrode E, the resistor is connected in parallel with the section of arc between movable arcing contact C and electrode E. As the fault current decreases, after reaching its maximum value during the first half cycle, arc resistance increases rapidly. This tends to cause the current to take the path from stationary contact C_1 to electrode E and through the resistor to D. The section of arc between moving contact C and electrode E then becomes unstable and goes out.

The arc between electrode E and the stationary contact is momentarily maintained after the main arc between electrode E and contact C is extinguished. The resistor connected in series with this remaining arc limits the current to load proportions and causes an improvement in circuit power factor, resulting in a marked reduction in the instantaneous value of the generator voltage at current zero.

Connecting the resistor into the circuit also dampens high-frequency tran-

(*Continued on page 132*)

Fig. 2—A 1200-amp, 15,000-volts, 500,000-kva-interrupting-capacity air-blast breaker

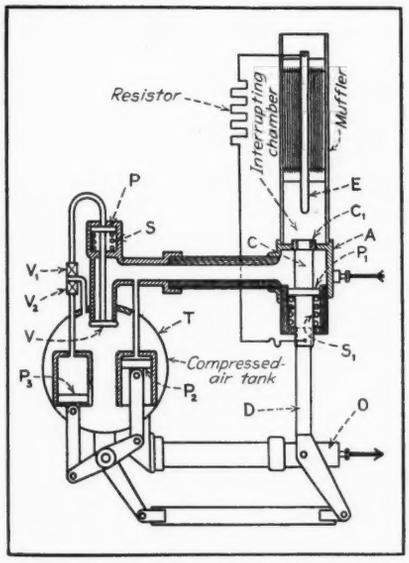


Fig. 3—Diagram of axial air-blast circuit breaker—closed

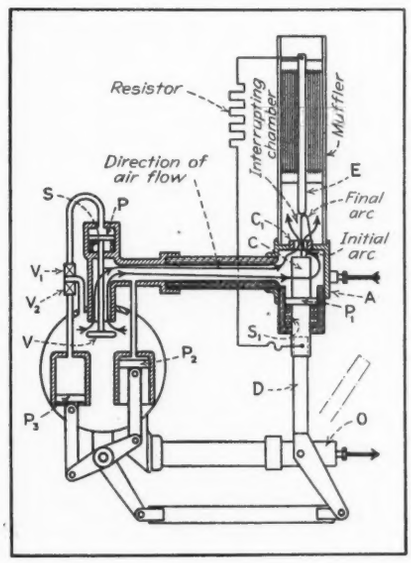


Fig. 4—Same as Fig. 3, but with arcing contacts open during interruption

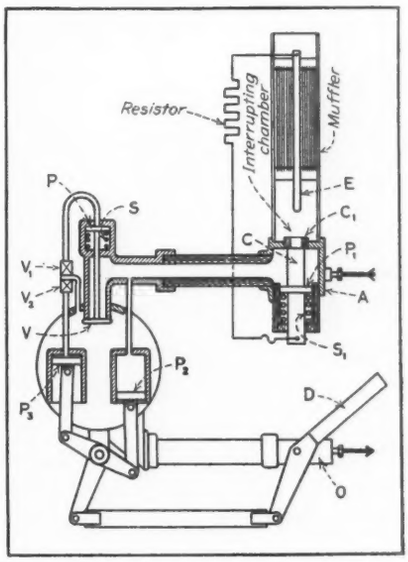


Fig. 5—Same as Fig. 3 after isolating contacts have opened

Common Sense Licks The Depression,

By using common sense and determination, Garnerville, N. Y., business men beat the depression; by improving boiler-plant operation and installing new boilers, they lifted efficiency from 45 to 87 per cent and can now burn the most economical fuel available

W F Larkin (left), president, and George W Conklin, plant engineer of the Haverstraw Industrial Terminal, keep an eagle eye on operating costs

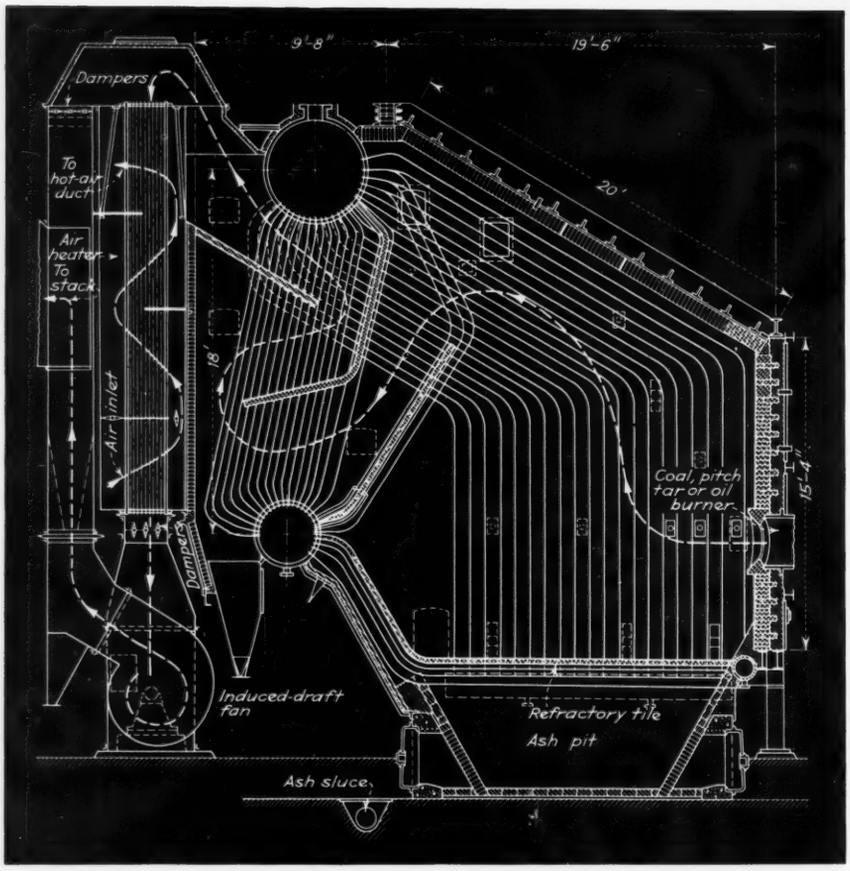


Fig. 1—Cross section of large boiler. Waterwalls entirely enclose furnace side walls, roof and bottom, and connect waterwall headers with top steam drum

▶ THE HAVERSTRAW INDUSTRIAL TERMINAL, at Garnerville, N. Y., owned and operated by the Garnerville Holding Co, Inc, generates its own power by oil engines and supplies steam for heating and process from a modern boiler plant. The story of the construction, modernization and operation of this plant is as interesting and instructive a power yarn as we have come across in many years. First, however, a brief summary of the entire project is in order, because it shows how "guts", determination, and horse sense defeated the depression.

History Before 1930

Garnerville, up until 1930, was a thriving industrial center with one large dyeing and finishing plant employing about 800 people. Came the crash, the company closed the plant, discharged its employees and moved away all the machinery, except an old boiler plant. Hundreds of people went on relief and many other hundreds fought to keep the wolf away from the door.

This condition continued until 1934—then the business men of the community, under the leadership of W F Larkin, formed the Garnerville Holding Co, Inc. This organization bought the finishing plant at junk value and

Boosts Plant Efficiency at Garnerville

proceeded to rehabilitate it and rent space to small industries, to get a wide diversity of manufacturing and thus stabilize employment.

Average rental for space is about 25 cents per sq ft with free drinking water, process water, sewage disposal and steam heat in cold weather. Process steam at 90 lb is sold at 60 cents per 1000 lb and power at published rates of the local utility company. This project, now known as the Haverstraw Industrial Terminal, has been so successful that nearly twice as many people are now employed as were before the old plant was abandoned, and the community has again been restored to prosperity.

Old Boiler Plant

When the present owners took over the plant. steam was generated in 18 old firetube boilers, of about 2400 sq ft water-heating surface each. All power was purchased. One of the first problems was to rehabilitate the steam and power facilities at as low cost as possible until the project was well under way. All engineering work has been done directly under the supervision of George W Concklin, plant engineer of the terminal, who came with the company in 1935.

Tests on the old hand-fired boilers showed that they could be operated at only 45% boiler and furnace efficiency. The settings were in poor condition and there was about 0.1 in. of hard scale on the water side of the tubes and boiler shell. By proper feedwater treatment all scale was removed from the boilers in two months. During this period the scale came down so fast it was necessary to inspect the boilers each week to prevent scale accumulating where it might cause burning of the shell or tubes.

These boilers were set so low, 24-in. from the grates, that it was necessary to burn a low-volatile coal to obtain reasonable efficiency. In 1935 the differential between coal and oil prices swung oil-wards sufficiently that a change to oil firing was made. By removing the grates and excavating in the ash pit, sufficient furnace volume was obtained to burn oil with an efficiency of 73%.

The next important step was taken in 1937—the organization installed its own power-generating plant. This consists of three 300-hp, 2-cycle oil engines direct-connected to 240-volt, 60-cycle, 3-phase, 4-wire, 250-kva, 0.80-pf flywheel-type alternators. The engines operate on a 50-50 mixture of diesel and No. 2 furnace oil. Operators discovered that this combination lowers the exhaust temperature about 25 F and decreases the fuel consumption 5% compared to straight diesel oil. With the latter, the units turned out 9.7 kw per gallon; on the mixture of diesel and furnace, 10.2 kw per gallon is obtained.

The only use of exhaust-gas heat is warming the jacket cooling water. Jacket water flows by gravity through coils in exhaust-gas pots where it is heated to about 110 F before entering the cylinder jackets. As long as the jacket-water discharge temperature remains below 130 F the water is recirculated. Above 130 F a thermal-controlled valve opens and the water goes to the feedwater make-up tank.

Over week-ends and holidays the power load may drop below where one unit will operate satisfactorily. Instead of installing a small unit for off-period loads, Mr Concklin found it more economical to operate one of the large units, using phantom load to keep the engine loaded to a satisfactory minimum. The phantom load consists of three electric heating units, rated 9, 18, and 27 kw, immersed in a tank of water. These heaters permit varying the load from 9 to 54 kw in 9-kw steps. Water heated in this tank and jacket water from the engine goes to the feedwater-storage tank serving one of the old boilers used for off-load service. In this way, a large part of the heat of the phantom load is utilized.

Steam and power loads have grown steadily. From 1936 to 1939, the yearly power load increased from 1,300,000 to 2,200,000 kwhr and the steam load from 214,000,000 lb to 425,000,000 lb. At present, the weekday power load ranges from 300 to 500 kw and the steam load reaches 150,000 lb per hr.

In 1938, new boilers were necessary. Steam demands had increased to near safe operating limits of the old boilers, and their condition was not all that might be desired. The project had proved successful and a new boiler plant could be financed easily. Estimated savings in fuel costs with a new plant that could take advantage of fuels available, and a possible improvement in thermal efficiency of from 8 to 15% made the investment in a new boiler very profitable.

Fig. 2—Power plant contains three 300-hp, 2-cycle oil engines direct-connected to 240-volt, 3-phase, 4-wire, 250-kva, 0.80-pf flywheel alternators

A boiler with continuous steaming capacity of 90,000 lb per hr was installed. Five old units were removed to provide space for the new one. The remaining old boilers were retained to help out in emergencies and to supply steam needed during week-ends and holidays. Although the boiler now operates at 90 lb pressure, it has a design pressure of 250 lb g. If, in the future, the price of diesel oil should increase beyond a certain value, it will become economical to install a noncondensing turbine. By putting a

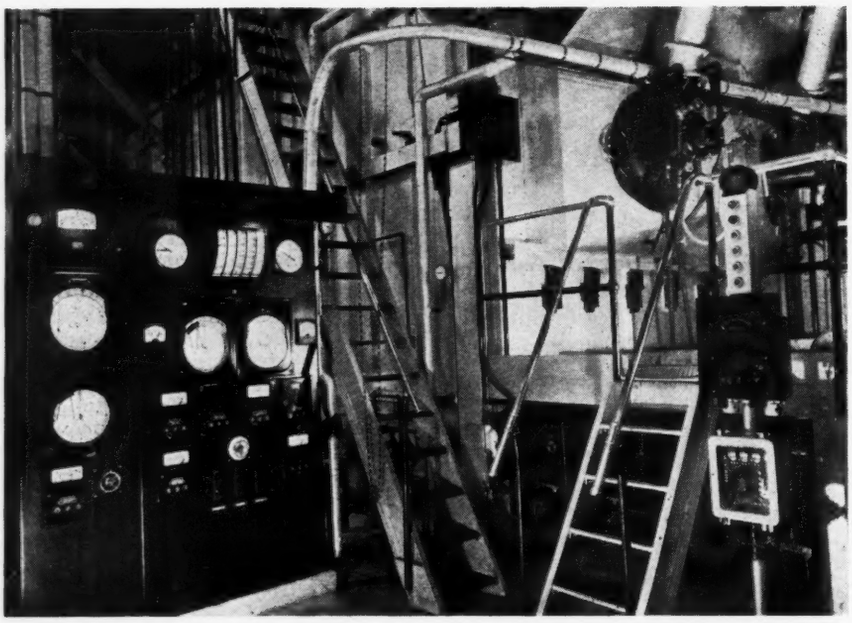


Fig. 3—Large boiler, rated at 90,000 lb of steam per hr continuously, is equipped with two combination coal, pitch, tar and oil burners

superheater in the boiler to add about 150 F to the steam temperature at 250 lb g, all power can be generated for the terminal with the turbine exhausting against 40-lb backpressure for heating and process.

Fig. 1 shows a cross-section of the 2-drum boiler. The drums are connected by a system of bent tubes that form the boiler proper and the waterwalls. The waterwalls entirely enclose the furnace side walls, roof and bottom, and connect the waterwall headers directly with the top steam drum. Feeder and floor tubes connect the waterwall headers directly with the bottom water drum. There is one feeder tube in the bottom of the furnace for every two tubes in the side walls. Side and roof waterwalls, so-called "shadow" type, are 4-in. away from the brickwork, which leaves the entire surface of the tubes exposed to radiant heat.

The boiler proper has two banks of tubes with space between for a convection-type superheater. Tubes in the front bank, 3¼ in. in diameter, and arranged 3 deep and 24 wide, form the primary steaming section. The rear-bank tubes, 2-in. in diameter, are 16 deep and 39 wide. Even though an integral part of the boiler, these tubes virtually form an economizer section. They all enter the drum well below the water level and serve both as steaming and feeder tubes for both boiler and waterwalls.

A vertical, tubular air preheater at the boiler rear gives a combustion-air temperature of 300 F and an exit-gas temperature of 340 F when the boiler is delivering 80,000 lb of steam per hour. Gas from the last pass of the boiler flows downward, see Fig. 1, through the air-heater tubes into the induced-draft fan, which discharges upward into the stack connection.

The forced-draft fan discharges into the bottom of the air heater. After the air makes four passes through the heater, it goes into the heated air duct leading to the burners. Dampers are provided at the top of the first pass in the air heater. By opening the left-hand damper and closing the right-hand one, the boiler-room operator can bypass the lower section of the heater to keep the gas temperature above the dew point at low ratings.

There are also dampers at the top and at the bottom of the air heater. By opening the top damper and closing the bottom one, boiler gases can be taken over the top of the air heater down into the stack breeching. Without the induced-draft fan and air heater in service the boiler can be operated up to 60% of maximum-continuous rating, but with about 7.5% decrease in efficiency.

A ball-mill pulverizer was chosen because it will handle any kind of solid fuel available—coal, coke or pitch. Solid fuel is stored in a 200-ton vertical concrete block bunker from where it is weighed automatically to the direct-current-motor-driven mill feeder. Speed of this feeder is automatically regulated to maintain a constant fuel level in the mill. Indicating lamps show high and low coal level in the mill and an alarm bell sounds when either of these limits is reached. Normally, there is sufficient fuel in the mill to operate the boiler for about 20 minutes.

The mill is driven by either a 2-speed ac motor or a steam turbine, depending upon which is needed to maintain a heat balance for feedwater heating. The primary-air fan on the mill is direct-current-motor driven. When pulverizing coal, primary air through the mill is taken from the heated-air duct and when pulverizing pitch, this air comes from outside the plant. Cold primary air is necessary with pitch because it softens at 190 F.

Fuel Burners

The pulverizer discharges to either or both of the two burners. A cross-section of one of the burners, which will burn solid or liquid fuels, or both at the same time, is shown in Fig. 4. When firing pitch, the burner is water cooled to prevent the pitch from softening until it is inside the ignition head. Combustion air for burning pulverized fuel comes to the burner in three ways. Secondary air delivered around the

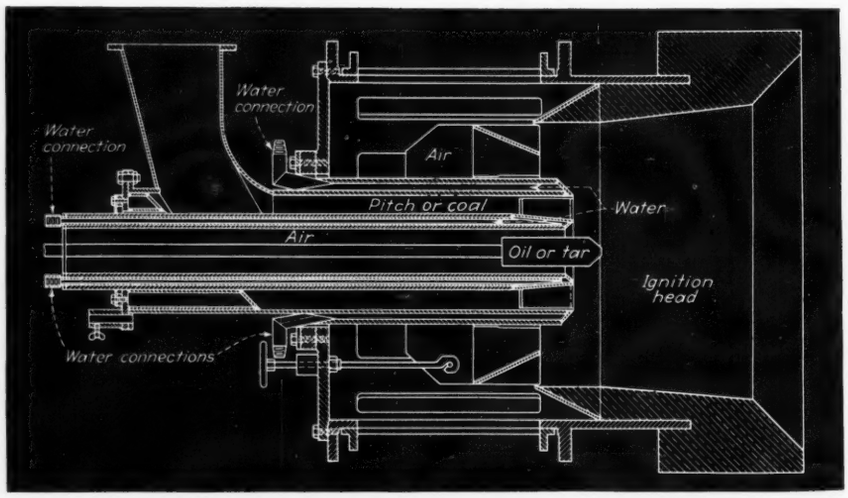


Fig. 4—One of the large-boiler burners, water-cooled when burning pitch

outer rim of the burner discharges towards its center. Primary air and fuel inside the secondary-air jet also tends to go to the center of the burner. Secondary and primary air pressure is around 2 in. of water but varies according to the load on the boiler.

Through the center of the burner a high-velocity, supercharging jet of air at about 7-in. water pressure shoots into the primary and secondary air streams directed toward the center of the ignition head. The latter creates violent turbulence to mix the fuel and air intimately. When firing oil or tar the fuel is atomized through a nozzle in the center of the burner as it is intimately mixed with the secondary air by the high-velocity supercharging air. With one burner in operation the boiler can be satisfactorily operated down to about 5000 lb of steam per hour and with both burners up to 90,000 lb continuously, burning any type of fuel.

Draft Fans

Induced-draft, forced-draft, and primary air fans are driven by direct-current motors, which permit a wide range of speed control in small steps. Speed-regulating rheostats on the draft-fan motors have 45 control points. One boiler-feed pump has an ac motor drive; the other a steam turbine.

A 75-kw direct-current generator, driven by either a 115-hp steam turbine or a 100-hp synchronous motor connected to the generating system, supplies power for the direct-current motors. The synchronous motor may be operated as an alternating-current generator to supply power to the power-plant busbars. The turbine exhausts to the feedwater heater as do the feed-pump and pulverizer turbines when they operate. The auxiliary turbines are operated according to steam requirements for feedwater heating to maintain heat balance.

Because a large part of the process steam is used for direct heating, feedwater is about 85% makeup, which is raw filtered water. All water treating is done in the boiler, impurities being disposed of by continuous blowdown.

In 1939 steam-load increase justified another boiler. This unit has a maximum continuous steaming rate of 55,000 lb per hr. Its general design is the same as the large one but it is equipped to burn oil or tar only and does not have an air heater. These modifications saved about 25% in cost of equipment and installation.

In regular operation the large boiler carries a major part of the base load and the small one takes the swings. Thus, little is lost in plant efficiency because there is no air heater on the latter. If load increases further, an air heater can be installed later.

Both boilers are equipped with automatic combustion control and are metered so that they can be operated under practical test conditions at all times. All meters are in charge of one man who keeps a careful check on them for accuracy. Steam from each boiler is metered to all services and tenants. These meters are read every day; when the totals from the boiler and distribution meters vary by more than 2% a check is made to correct the cause.

Efficiencies

About 75% of the steam is produced by the large boiler. When burning tar, an average boiler and furnace efficiency of 86% is obtained; with oil, efficiency is 85%, and with pitch, because of using cold primary air, efficiency drops to 81%. This lower efficiency is taken into account when comparing the cost of pitch with other fuels. Up to the present time the boiler has not been operated on coal, because at no time has the price of coal justified doing this. Change from one fuel to another can be made so easily that it cannot be detected on the pressure gage. Load swings of as high as 60,000 lb of steam per hour have been picked up by the large boiler in five minutes.

PRINCIPAL NEW POWER EQUIPMENT

Haverstraw Industrial Terminal, Garnerville, N. Y.

Steam-Generating Equipment:

Boilers, waterwalls, settings, breechings.....Kennedy-Van Saun Mfg & Engrg Co
Boiler No. 1, 2-drum, heating surface, 5860 sq ft; waterwalls 1640 sq ft; rated max continuous steaming capacity, 90,000 lb per hr; design pressure, 250 lb g; working pressure, 90 lb g; total steam temperature, saturated; effective furnace volume, 3700 cu ft; Btu liberated per cu ft of effective furnace volume per hr, 24,000 at max rating. Boiler No. 2, 2-drum, heating surface 6800 sq ft; waterwalls 700 sq ft; rated max continuous steaming capacity, 55,000 lb per hr; design pressure, 175 lb g; working pressure 90 lb g; total steam temperature, saturated; effective furnace volume, 3600 cu ft; Btu liberated per cu ft of effective furnace volume, 21,000 at max rating
Air preheater for Boiler No. 1.....Kennedy-Van Saun Mfg & Engrg Co
Tubular type, heating surface, 7500 sq ft; max air temperature at max rating, air 300 F, gas to stack 340 F
Boiler heat-insulating brick.....Armstrong Cork Co
Boiler heat insulation.....Ehret Magnesia Mfg Co
Baffle tile.....National Refractories Co
Foundations.....Ward Bros, Inc

Combustion Equipment:

Automatic combustion control.....The Hays Corp
Soot blower.....Bayer Co
Burners, Boiler No. 1.....Kennedy-Van Saun Mfg & Engrg Co
2, combination coal, pitch, tar or oil, capacity 60,000 lb per hr each
Oil guns, for above burners.....The Engineer Co
Burners, boiler No. 2.....The Engineer Co
2, combination oil and tar, capacity 35,000 lb per hr each
Pulverizer, coal and pitch, Boiler No. 1....Kennedy-Van Saun Mfg & Engrg Co
Ball-mill type 5.5 x 6 ft; capacity: coal 6000 lb per hr, 85% through 200 screen mesh, pitch 8400 lb per hr. Dual motor and turbine drive
Geared turbine, 65 hp, for pulverizer.....Elliott Co
Motor, 65 hp, 2-speed, ac, for pulverizer.....Crocker-Wheeler Elec Mfg Co
Motor controller.....Cutler-Hammer, Inc.
Primary-air fan, mill exhauster.....Kennedy-Van Saun Mfg & Engrg Co
Primary-air fan, dc motor, 15 hp.....Crocker-Wheeler Elec Mfg Co
Motor, adjustable-speed controller.....Cutler-Hammer, Inc.
Coal feeder and mill-level control.....Kennedy-Van Saun Mfg & Engrg Co
Coal and pitch scale.....Richardson Scale Co
Forced-draft fan, boiler No. 1.....Buffalo Forge Co
Forced-draft fan dc motor, 40 hp.....Crocker-Wheeler Elec Mfg Co
Motor, adjustable-speed controller.....Cutler-Hammer, Inc
Induced-draft fan, boiler No. 1.....Buffalo Forge Co
Induced-draft fan dc motor, 40 hp.....Crocker-Wheeler Elec Mfg Co
Motor, adjustable-speed control.....Cutler-Hammer, Inc
Forced-draft fan, boiler No. 2.....Buffalo Forge Co
Forced-draft fan ac motor, 10 hp.....U.S. Electrical Motors, Inc
Coal-handling equipment.....Nicholson Co
Concrete-block, 200-ton bunker, track hopper, bucket elevator and conveyor

Piping, Valves and Fittings:

Piping.....Central Engrg & Supply Co
Pipe heat insulation.....Johns-Manville Co
Traps.....Armstrong Machine Works
Safety valves.....Edward Valve & Mfg Co
Blowoff valves.....Edward Valve & Mfg Co
Non-return valves.....Edward Valve & Mfg Co
High-pressure valves.....Edward Valve & Mfg Co
Low-pressure valves.....Jenkins Bros
Reducing valves.....Spence Engineering Co

Feedwater System:

Feedwater heater.....Cochrane Corp
Continuous blowdown.....Cochrane Corp
Water columns.....Reliance Gauge Column Co
Feedwater regulators (Copes).....Northern Equipment Co
Feed pumps.....De Laval Steam Turbine Co
2, one turbine-driven, one motor-driven
Turbine drive, 40-hp, 3500-rpm.....De Laval Steam Turbine Co
Motor drive, 40-hp, 3500-rpm.....Westinghouse Elec & Mfg Co
Motor controller.....Cutler-Hammer, Inc
Feedwater-treatment pump.....Trench Marine Co
Feedwater-makeup pump.....De Laval Steam Turbine Co
Motor drive.....Westinghouse Elec & Mfg Co
Feedwater-treatment engineer.....Edward C Grief

Meters and Instruments:

Steam flowmeters.....Cochrane Corp
Pressure recorders.....Bristol Co
Temperature recorders.....Hays Corp
CO_2 recorders.....Hays Corp
Steam-pressure gages, indicating.....Crosby Steam Gage & Valve Co
Oil-pressure gages.....United States Gage Co
Thermometers, dial.....Taylor Instrument Cos
Flame control, electric eye.....Wheelco Instrument Co
Draft, gage, 5-point.....The Hays Corp
Ac and dc voltmeters.....General Electric Co

Power-Generating Equipment:

Oil engines, 3, 2-cycle, 300-hp.....Venn-Severin Machine Co
Alternators, 3, 3-phase, 60-cycle, 240 volts.....Ideal Elec & Mfg Co
Auxiliary dc generator turbine.....De Laval Steam Turbine Co
Electrical contractor.....Electric Service Repair Co

Largest Gas-Engine Central Station Averages 1.84 Mills per Kwhr

Rea Station, Louisiana Ice & Electric Co, turns in outstanding first-year operating record. F H Coughlin, vice-president and general manager, presents engine test data and complete production-cost figures for this 3000-kw public utility plant

▶ COMBINE internal-combustion-engine efficiency, low-cost gas fuel, and intelligent operation; no one will be surprised if remarkably low power cost results. That's the formula at Rea Station, Bunke, La., owned by the Louisiana Ice & Electric Co. When this plant was completed in December, 1938, it was reported as the largest gas-engine central station. Test and operating results, summarized here, indicate it one of the most efficient as well.

Three Worthington, twin-six, 4-cycle, 18x25-in., 225-rpm, 1500-hp gas engines drive direct-connected Westinghouse alternators rated at 1250-kva. A closed system with Bentube sections cools the engines. The plant has all the conventional accessories plus a comprehensive set of metering equipment to provide detailed operating data. This includes a Sargent calorimeter with which gas analyses are made two or three times a week.

After a "tuning-up" period, each of the three units was thoroughly tested for performance and efficiency; F C Landers Jr represented Louisiana Ice & Electric Co and H P Yount the Worthington Pump and Machinery Corp. A water rheostat consisting of three 1-in. pieces of shafting suspended in the basin of the ice-plant cooling tower and manipulated for height by a system of pulleys, ropes and a hand crank, provided necessary load. Wires brazed to the shafting and connected to aluminum wiring suspended across the yard, and 3-wire lead-covered cable into the building formed the connection to the generator side of the bus disconnects back of the switchboard.

To measure gas flow, a 1¾-in. orifice was inserted in the 6-in. line from the station gas header to the control cock of

TABLE I—ABSTRACT OF TEST DATA—REA STATION

Louisiana Ice & Electric Co, Bunke, La.

Engine G-989-90

	122.5%	110%	100%	75%	50%	0%
Duration	6 min	2 hr	12 hr	20 min	6 min	5 min
Indicated kw	1,225	1,104	1,003	733	578	0
Generator efficiency	95.25	95.20	95.10	94.65	94.15	.....
Brake Horsepower	1,725	1,620	1,427	1,040	823	.....
Corrected cu ft gas per hr	12,750	11,770	11,170	8,670	7,680	4,430
Higher heating value of gas	1149 Btu/cu ft.		Net value = 1044 Btu/cu ft			
Millions of Btu per hr, net	13.32	12.30	11.67	9.05	8.02	4.62
Net Btu per kwhr	10,870	10,690	11,530	12,340	13,860	.....
Net Btu per brake hphr	7,720	7,590	8,170	8,700	9,730	.....
Engine thermal efficiency, %	33.0	33.5	31.2	29.3	26.1	.....
Unit over-all thermal eff, %	31.4	31.9	29.6	27.7	24.6	.....
Engine rpm	225	225	225.5	225	225	225
Exhaust temp, No. 7 cyl, F	.....	912	928	850	825	.....
Exhaust temp, right line, F	.....	852	869	800	780	.....
Exhaust temp, left line, F	.....	785	813	725	700	.....
Water temp into engine	121	121	116	121	121	120
Water temp from heads	132	135	130	132	132	131
Water temp from engine	136	143	137	140	136	135
Lube-oil temp from engine	127	127	124	127	127	127

TABLE II—OPERATING RESULTS—REA STATION

Louisiana Ice & Electric Co, Bunke, La.

12 months ending Jan 20, 1940

OPERATING DATA

Rated station capacity	3000 kw
Gross generation[1]	13,545,500 kwhr
Station use[1]	496,117 kwhr
Net generation	13,049,383 kwhr
Station use[1]	3.66%
Plant running capacity factor	69.4%
Total capacity availability factor;	
Unit No. 1	99.6%
Unit No. 2	99.3%
Unit No. 3	98.5%

OPERATING RESULTS

Total gas used, M cu ft	159,048
Total Btu (millions)	182,607
Mean Btu per cu ft gas	1148
Gas per net kwhr, cu ft	12.19
Btu per net kwhr	13,994

FUEL COST

Gas cost, cents/M cu ft	4.99
Gas cost, cents per Million Btu	4.34

EMPLOYEES

Number (operation)	7
Number (maintenance)	2
Man hours (operation)	17,441
Man hours (maintenance)	2,151

PRODUCTION COST

Supervision and labor	$9,554.60
Fuel	7,943.10
Lubricating oil (3608 gal)	1,747.24
Water, misc	1,726.90
Maintenance labor	844.25
Maintenance material	2,221.48
Total cost	$24,037.57

PRODUCTION COST PER NET KWHR (MILLS)

Operating labor	0.73
Fuel	0.61
Lubricating oil	0.13
Water, misc	0.13
Maintenance labor	0.06
Maintenance material	0.17
Total cost	1.84

[1] *Exciters are chain-belt driven, therefore energy requirements are in addition to the figures given.*

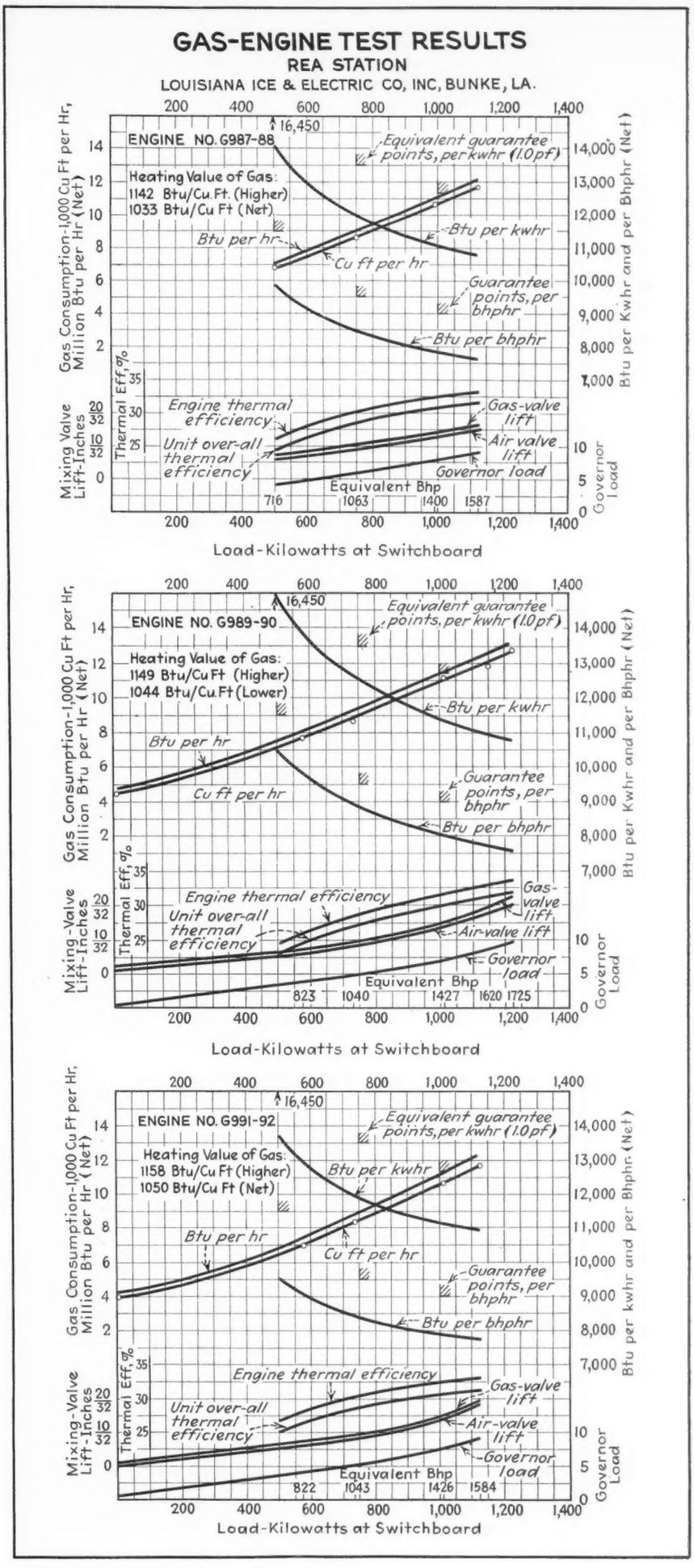
the engine under test. The American Meter Co furnished the orifice and flanges, which were fitted with flange taps. Measurement of pressure and differential across the orifice was by Meriam manometers. All meters were calibrated for the test. Table I gives the principal test records and results, the curves summarize data for each engine.

Before proceeding to the operating data in Table II, it should be pointed out that the three units described above constitute an extension to a small oil-engine plant consisting of two 6-cyl, 2-cycle, 540-hp, Worthington diesels, each direct connected to a 375-kw generator; these are held as standby to the new units. An ice-plant engine room also adjoins the new engine room and the operators take care of the ice-plant machinery. Thus, neither ice-plant engine room nor the oil engines charge any attendance other than that included in the cost of gas-engine plant operation reported below, and no operating charges were prorated to these functions. Fuel oil, lubricating oil, etc., purchased specifically and only for these other plants, is, of course, charged to them directly.

Production Costs

Table II gives significant operating statistics and a summary of production costs for the 12 months ending January 20, 1940. These figures do not include interest, amortization, depreciation, or similar charges. In operating diesel units under similar conditions we found that it was necessary to replace liners at the end of eight years. Micrometer measurements on these units, to date, fail to show enough wear to forecast liner replacement. We have, therefore, set up an arbitrary reserve of 0.4 mills per kwhr, in addition to costs tabulated above, to provide for this contingency. Creating this unusual reserve might find a steam-plant parallel in setting up a maintenance reserve for reblading turbines, or retubing boilers.

On May 27, 1940, another Worthington twin-six unit, similar to those described except for size and use of oil-cooled pistons, was added at Rea Station to drive a 1563-kva General Electric generator.



Defense Work for Everybody

By PHILIP W SWAIN, *Editor*

McGraw-Hill's Job

June POWER brought you "Industry Organizes for National Defense," a message from James H McGraw, Jr, to the readers of 24 McGraw-Hill publications—more than a million engineers and business men closely associated with American industry.

Mr McGraw's message, to which POWER subscribes without reservation, was a plan for coordinated action. The announced National Defense Editorial Board, manned by the chief editors of our technical and business publications, went into action immediately. Its first step was to select S T Henry as the full-time Washington contact man of the Board. Mr Henry, ideally suited for both the industrial and journalistic aspects of this important assignment, is devoting his entire time to war problems as they affect industry. Meanwhile the McGraw-Hill news bureau in Washington functions as usual.

In addition the editors are making frequent individual trips to Washington to confer with key men in governmental departments and agencies. Through such channels each editor will constantly relate America's evolving preparedness program to the work of his particular industrial field as seen through his industry contacts.

POWER'S Job

Taking full advantage of this cooperative fact-finding and thinking, POWER, as always, will assume full individual responsibility for any facts and recommendations it passes along to its readers. Here, in brief, is our present plan:

1—We shall maintain close touch with the general war situation in the manner already outlined.

2—We shall pay particular attention to the industrial picture as it unfolds, remembering that the way industry is handled will largely determine the effectiveness of our national defense measures.

3—We shall carefully study the power-service problems of industry in their relation to national defense.

4—As rapidly as trends are revealed we shall work for such action on the part of government and the men of the power field as will insure the delivery of electric power, process steam, and other power services when and where needed for the defense program.

In short, we shall roll up our sleeves in the cause of "power to serve industry to serve defense."

Industry's Job

What American industry needs at this time is speed, not haste. Every engineer, every mechanic, every surgeon knows the difference. Let's find out where the fire is before we rush to a hydrant.

Urgently needed defense equipment will include ships, small arms, heavy ordnance, shells and powder, mechanized military equipment, planes, engines. With the best of management we can hardly produce all of these requirements, in adequate quantity, before 1943. Certain bottle necks—notably the many months required to train mechanics and "tool up"—will delay the start of mass production.

From the defense angle alone, the broad ocean may give us time enough if we can work very fast, but *without haste*, planning and preparing our industrial program as the experienced housewife plans and prepares a big dinner on short notice.

In executing such a plan, American leadership, if wise, will save time and avoid bungling by using existing institutions and experience to the limit. Men who have learned how to build and run factories will build and run them. Soldiers will train soldiers. Generals will determine military needs. Power engineers will run power plants.

Your Job

In this tremendous national task of the next two, three or four years—perhaps more—your major duty as a power engineer is obvious. As a citizen you may be asked to send your son to the army or navy, to pay bigger taxes, do this or that. Far more important will be your job of keeping industry's wheels turning, juice always on the line, process steam and other services on tap.

At the moment the situation in these respects looks fairly safe. We have found no evidence to justify sounding an alarm of impending power shortage or coal shortage, either this year or next. Yet nothing should be taken for granted.

Power engineers of industrial plants making, or likely to make, essential war products, should check their power-service spares and standby capacity with a view to probable two- or three-shift operation—possibly seven-day operation as well.

Will you have enough dependable spare capacity to permit routine repair and maintenance without endangering continuous operation? Is everything shipshape, with decks cleared for action? A careful check now becomes a matter both of patriotic duty and of simple common sense.

These Men Stand for Safe Steam

Owsley Brown, Springfield Boiler Co; Starr H Barnum, The Bigelow Co

All captions read left to right

► EVERY YEAR, as the July issue rolls around, POWER carries a brief news item to the effect that the ABMA & AI has met again for its annual June convention, has held business sessions, golfed, elected new officers, etc. This July, we feel the time has arrived (perhaps we should have done it before now) to introduce this association and its members to the men who design and operate power plants.

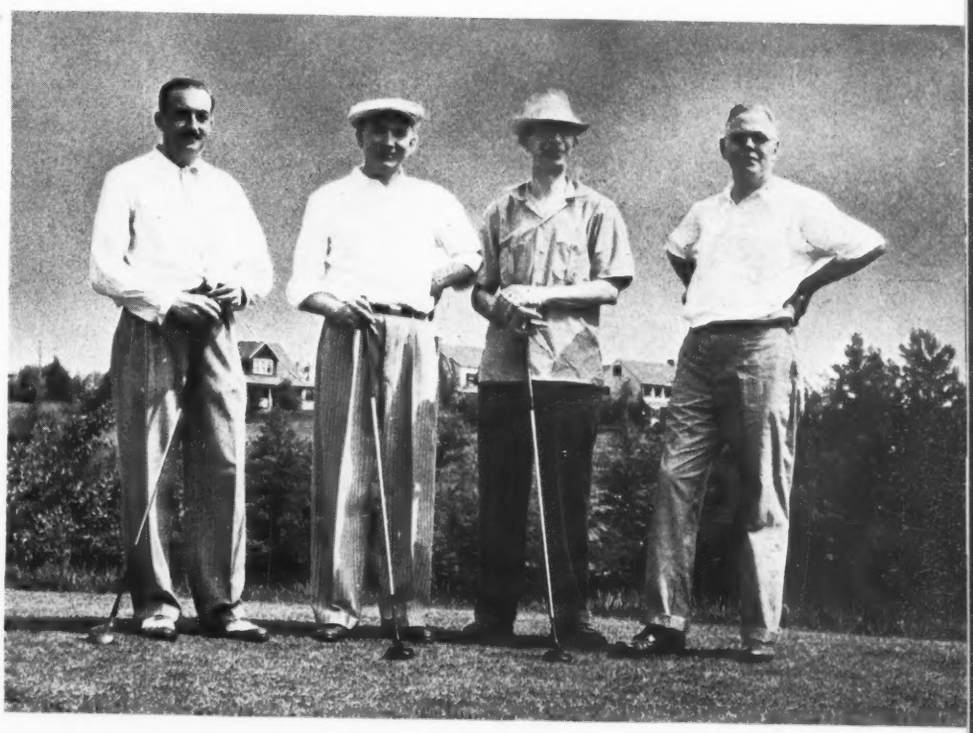
What the Association Is

As the name implies, the American Boiler Manufacturer's Association and Affiliated Industries is a trade association of companies engaged in the manufacture of power boilers and associated equipment. Active membership is limited to those companies that make the major elements of the steam-generating unit—the boiler proper, the stoker, the pulverizing equipment, the superheater, the air preheater.

Associate members are companies engaged in the manufacture of boiler accessories and materials—such items as safety and blowdown valves, refractories, boiler tubes and plate and regulators—also the boiler insurance companies and related commercial and noncommercial organizations concerned with boiler laws, boiler inspection, etc —also power-field publications.

So far, several things should be apparent. One is that every power engineer has an indirect stake in the operations of this group, since it designs, builds, sells, and sometimes installs equipment which he buys and operates, and since this group, to a very substantial degree, cooperates with organizations concerned with the safety of such equipment and hence with the lives and property of owners and operators.

Second point is that this association is designed for the cooperative action of the members for the good of the industry. This last automatically involves consideration of the users' needs, the



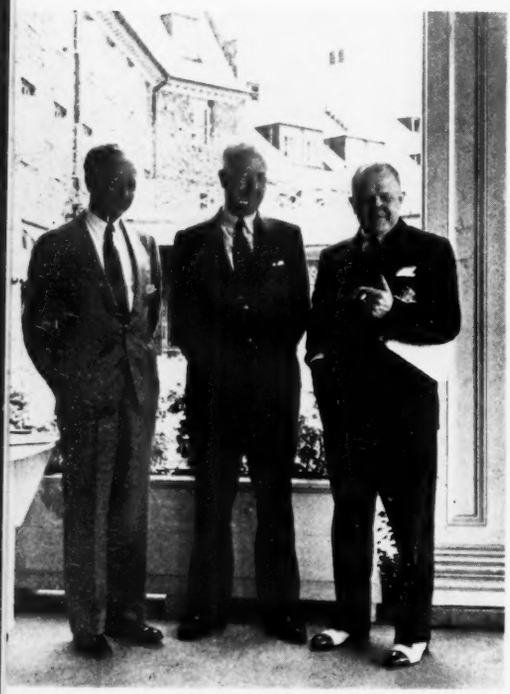
E T Knobloch, Union Iron Works; E F Simon, Ohio Machine & Boiler Works; A C Weigel, Combustion Engineering Co; A G Pratt, Babcock & Wilcox Co

J F Coburn, J F Corlett & Co; Pell W Foster, Foster Wheeler Corp

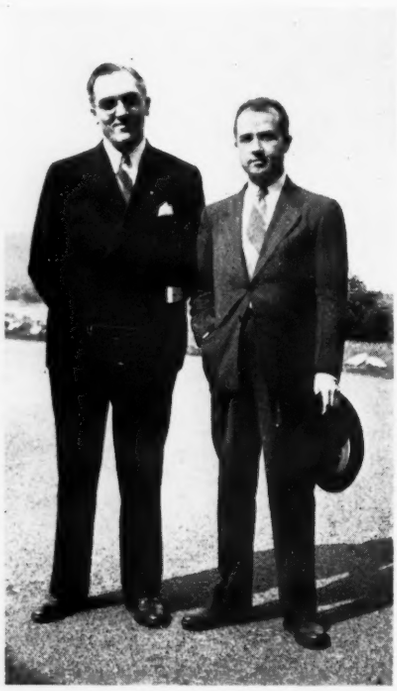
W H S Bateman, W H S Bateman & Co; E R Stone, Westinghouse

E M Keyes, National Tube; M Isenburg, Combustion Engineering; J H Sengstaken, Air Preheater; J E Fleming, National Tube

Mrs Starr Barnum; I S Pieters, Plibrico; Mrs G Macnoe; Homer L Rank, Strong-Scott



E W Nick, Northern Equip; J R Brown, Reliance Gauge; W N McCreight, Vulcan



W H Pugsley, The Hays Corp; Carr Liggett, Reliance Gauge Column Co

cornerstone of all successful business.

Third, both active and associate members are broadly interested in the successful operation of the entire steam-generating set-up.

This year's meeting, held at Skytop Lodge, Skytop, Pa., June 2–5, was the 52nd Annual Convention. Officers elected were: President, E T Knobloch, Union Iron Works; vice-president, F H Daniels, Riley Stoker Corp; secretary-treasurer, A C Baker (re-elected for his 14th year). The E H Wells golf trophy (ABMA & AI championship, based on 36-hole low gross) was won by C L Myers, sales manager of American Engineering Co, R R Lally of Globe Steel Tubes Co won the 36-hole low net championship for associate members.

Following is a list of the members and associate members:

Members

Air Preheater Corp, American Engineering Co, Babcock & Wilcox Co, Bab-

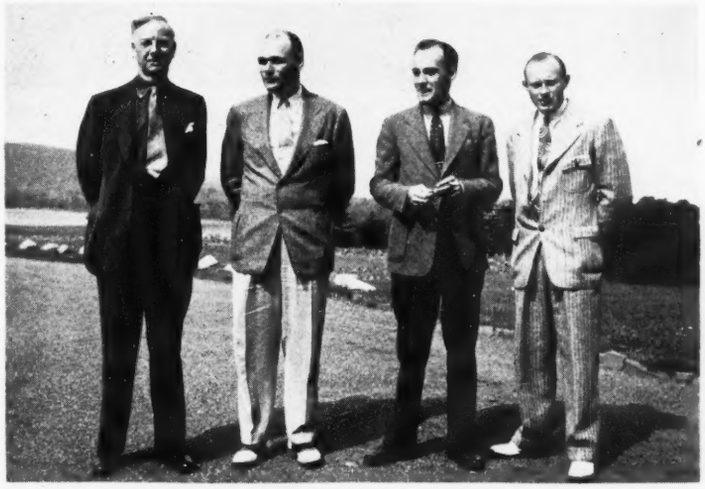
(*Continued on second page following*)

C O Myers, Nat'l Board of B & P V Inspectors; J P H deWindt, Nat'l Bureau of S & C Underwriters; Dan Royer, Ocean Accident & Guarantee Corp

C A Moore, Jr, and W J H Miller, both of Consolidated Ashcroft Hancock Co; George C Siefert, Combustion Engineering Co; F H Gordon, Lukens Steel Co

J M Gorham, Hartford Insurance; C E Gorton, Uniform Boiler Law Society; H B Vidal, Westinghouse; G R McAleenan, McAleenan Bros.

S G Farrington, Foster Engrg; H Freeman, guest; George W Bonnell and J C McDougall, Hoffman Combustion Engrg



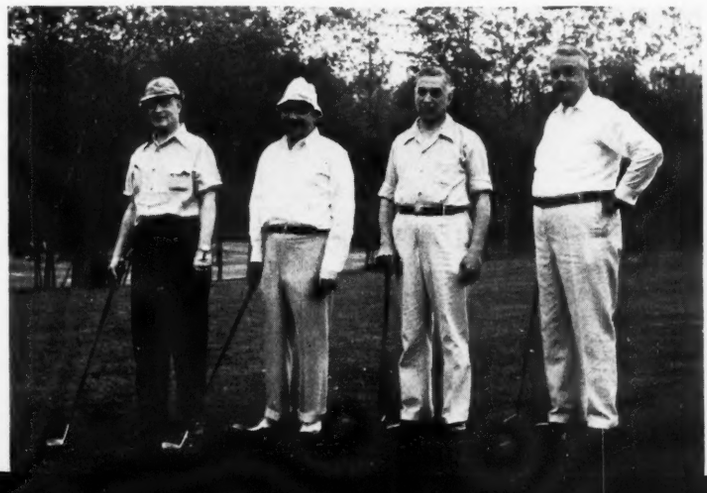
George F Fenno, Vulcan Soot Blower Co; S Louis Huyette and E H Owens, Paul B Huyette Co; T H Bateman, Bateman & Co

L W Nonnes, Diamond Power; A W Strong, Jr, Strong-Scott; George Macnoe, Foster Wheeler Ltd; R B Gray, Dominion Bridge

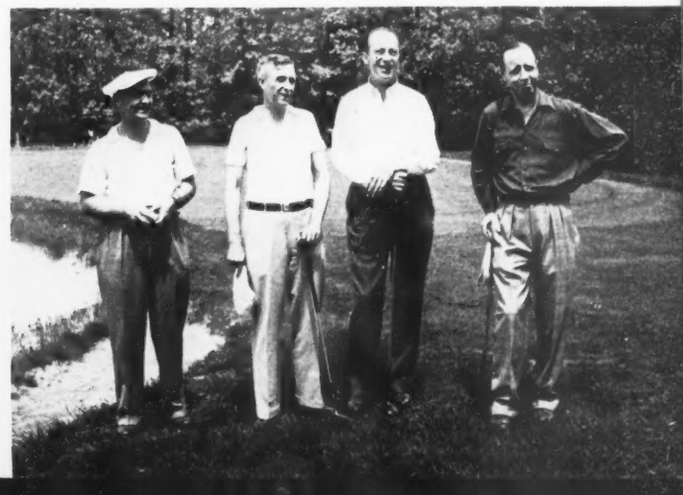
J C Trefts Jr, Farrar & Trefts; A R Maxwell; Pittsburgh Steel; I S Pieters, Plibrico; E C Webb, Iron Fireman; D Kendall, Farrar

H H Fleming and R J Davis, Johnston & Jennings; J G Eury, Henry Vogt Machine Co; C M Daniels, Bethlehem Steel

C J Bickler and R R Lally, Globe Steel Tube Co; Frank G Brinig, Erie City Iron Works; F W Chipman, International Engrg Works



J M Goodbar, Murray Iron Works; R L Beers, Detroit Stoker; G L Davis, Diamond Power; Thatcher W Rea, Detroit Stoker



P W Swain and N O Wynkoop, POWER

cock & Wilcox-Goldie McCulloch, Ltd, Bass Foundry & Machinery Co, The Bigelow Co, Wm Bros Boiler & Mfg Co, The Brownell Co, Combustion Engineering Co, Inc, Combustion Engineering Corp, Ltd, Detroit Stoker Co, D M Dillon Steam Boiler Works, Inc.

Dominion Bridge Co, Ltd, Edge Moor Iron Co, Erie City Iron Works, Farrar & Trefts, Inc, Foster Wheeler Corp, Foster Wheeler Ltd, Hedges-Walsh-Weidner Co, Hodge Boiler Works, International Boiler Works, International Engineering Works, Johnston & Jennings Co, Kewanee Boiler Corp, James Leffel & Co, McAleenan Bros Co, Murray Iron Works.

Ohio Machine & Boiler Co, Prat-Daniel Corp, Riley Stoker Corp, Springfield Boiler Co, The Strong-Scott Mfg Co, Superheater Co, Struthers Wells-Titusville Corp, Tudor Boiler Mfg Co, Union Iron Works, Henry Vogt Machine Co, Westinghouse Electric & Mfg Co, Wickes Boiler Co.

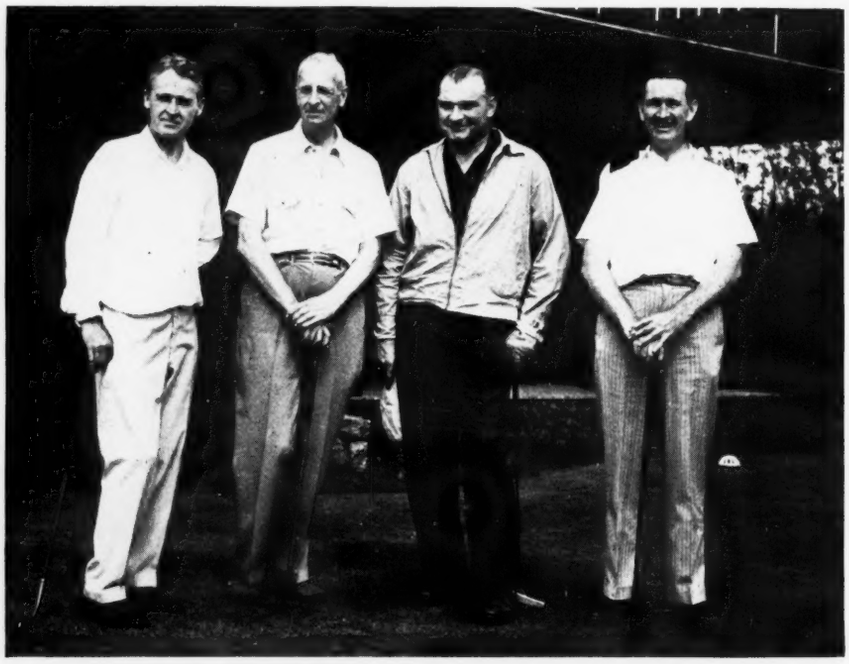
Associate Members

American Uniform Boiler Law Society, W H S Bateman & Co, Bethlehem Steel Co, Champion Rivet Co, Consolidated Ashcroft Hancock Co, Cochrane Corp, J F Corlett & Co, Crosby Steam Gage & Valve Co, Dampney Co of America, Detroit Seamless Steel Tubes Co, Diamond Power Specialty Corp, Foster Engineering Co, Globe Steel Tubes Co.

Hartford Steam Boiler Inspection & Insurance Co, The Hays Corp, Hoffman Combustion Engineering Co, Paul B Huyette Co, Iron Fireman Mfg Co, Lukens Steel Co, National Board of Boiler & Pressure Vessel Inspectors, National Bureau of Casualty & Surety Underwriters, National Tube Co, Northern Equipment Co, Ocean Accident & Guarantee Corp, Ltd, Otis Steel Co, Pittsburgh Steel Co, Plibrico Jointless Firebrick Co, POWER.

Reliance Gauge Column Co, Steel Improvement & Forge Co, Steel & Tubes, Inc, Travelers Indemnity Co, Vulcan Soot Blower Corp, Wheeling Steel Corp, Yarnall-Waring Co.

A C Baker, Secretary of ABMA & AI; L C Whiton, Jr, Prat-Daniel Corp; F H Daniels, Riley Stoker Corp; E I Anderson, Westinghouse Elect & Mfg Co



D Robert Yarnall, Yarnall-Waring Co; John Van Brunt, Combustion Engineering Co; C L Meyers, American Engineering Co; L M Hogan, Steel & Tubes, Inc

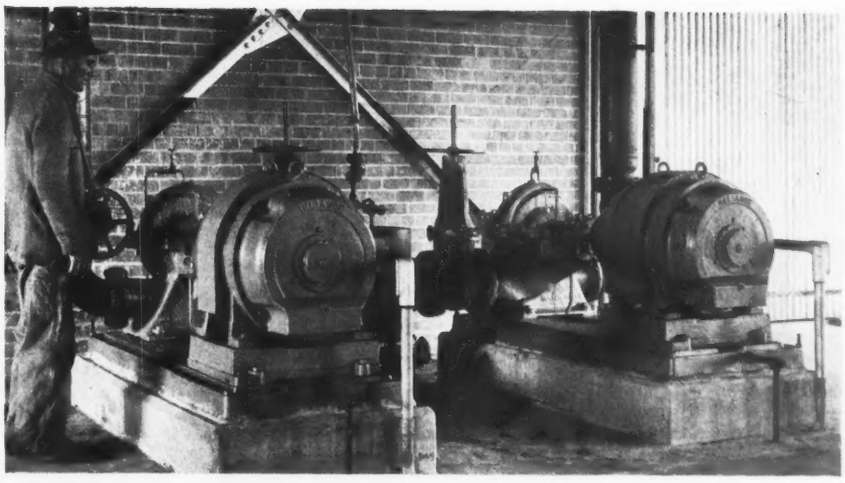
H E Aldrich, ABMA & AI; Starr Barnum, The Bigelow Co; E R Fish, Hartford Steam Boiler I & I Co; Owsley Brown, Springfield Boiler Co

Southern Pine Hits the Front Page

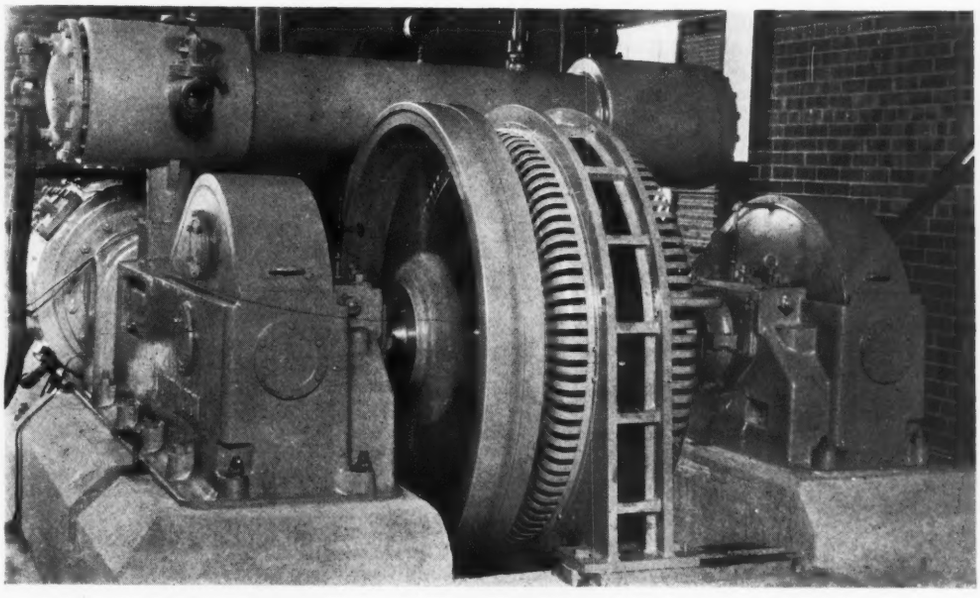
▶ JANUARY OF THIS YEAR, the Southland Paper Mills, Lufkin, Texas, began turning out the first commercial newsprint from southern pine—probably as far-reaching and important event as the first operation of Eli Whitney's cotton gin.

Although this newsprint is not yet 100% satisfactory, experienced papermakers are positive that minor difficulties will soon be ironed out. Most paper used by American newspapers comes from the northern states and Canada, where it takes the Creator from 50 to 100 years to make a tree suitable for the mills. Now, with man's ingenuity and kindlier climatic conditions, the

(Continued on page 94)

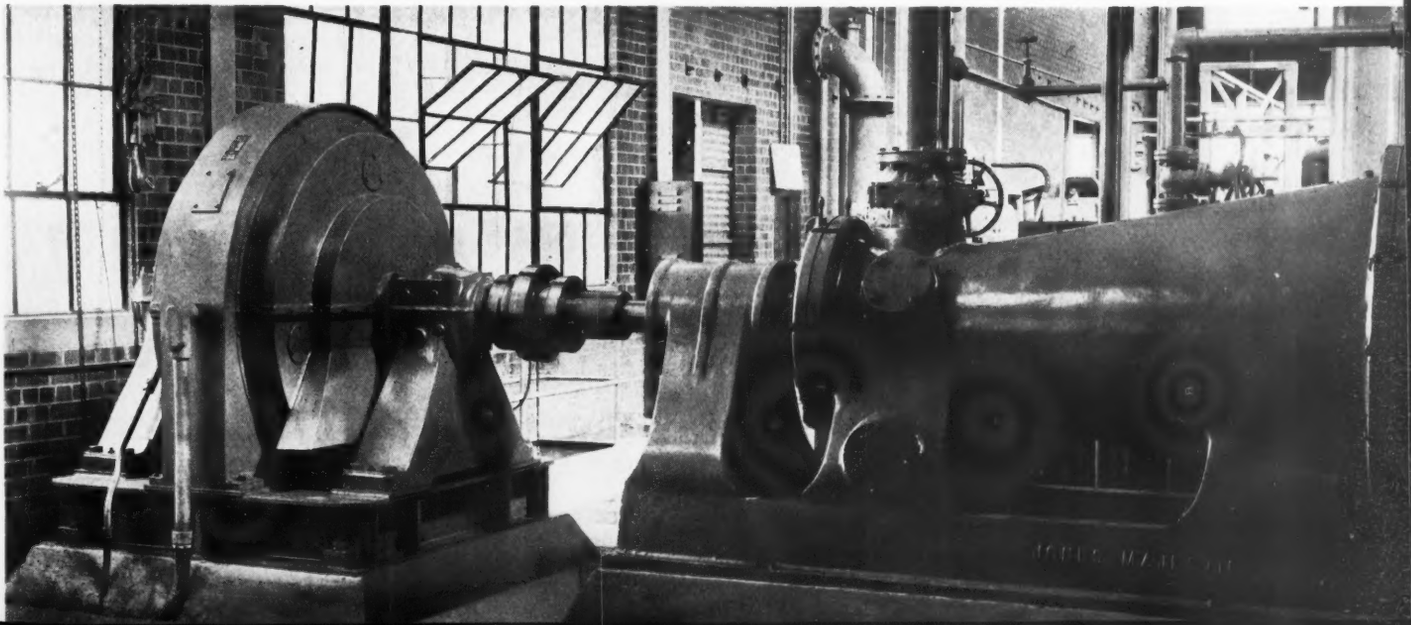


Goulds fresh-water twin pumps, 1500 gpm at 125-ft head, coupled to Reliance motors



The Worthington air compressor at Southland is driven by a 200-hp, 300-rpm, synchronous EM motor

350-hp, 400-rpm, synchronous, splash-proof Electric Machinery motor drives the large Jordan machine



AUTO ENGINE OIL OK FOR WATCHES!

Shell had 30,000 of these jeweled wonders especially made by one of Switzerland's most famous watchmakers, Girard-Perregaux. All the 30,000 are lubricated, NOT with $16 per quart WATCH oil, but with tough-bodied 25c per quart Golden Shell Motor Oil. Any Shell dealer will be glad to let you see one.

SHELL REFINERY · June 5 · *Important*

Imagine pieces of metal so carefully machined that they differ by only one-twentieth of a human hair —1/10,000 of an inch! "Super-finished bearings" in Chryslers. "Engines like a watch" is Packard's claim. "Watches rough in comparison" is the way Buick describes its new cars.

The problem: How to refine a pure enough oil to reach and *stay* on such surfaces. Shell has done it. Today Shell dealers have 30,000 exquisite, Swiss watches, keeping perfect time, lubricated with regular Golden Shell Motor Oil!

Problem two: "Well enough," you say, "But this might be a 'sissy' oil, which would wither under the blast-furnace heat inside my high compression engine!"

That's a fair question, but the answer is that Golden Shell *likes* heat and pressure! Put it in a cross country bus engine where you get *real* heat and pressure. It's in there *all* the time, never gives up. Put it in your car, old or new, big or little, and watch it take all the punishment you can dish out! A tough, fast-flowing, *full-bodied* oil if there ever was one.

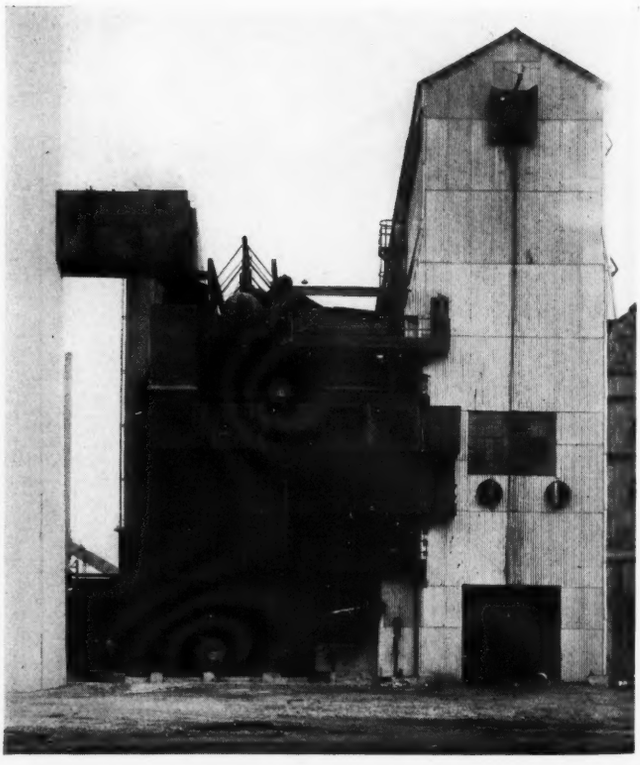
New Golden Shell

SHELL

THE MOTOR OIL FOR PRECISION-BUILT CARS

SHELL MOTOR
RILEY BOILER

To eliminate the large investment for a building to house the new Riley Boiler Unit which they recently installed at their Wood River, Ill., plant, Shell Oil Company merely housed the firing aisle, placing the entire unit outdoors. This is one of the first out-door boiler installations located where sub-zero temperatures occur. The unit was placed on the line when the temperature was 15° below zero.



SHELL OIL COMPANY, WOOD RIVER, ILL.
125,000 lbs./hr. Riley Steam Generating Unit
fired with Riley Pulverizers

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

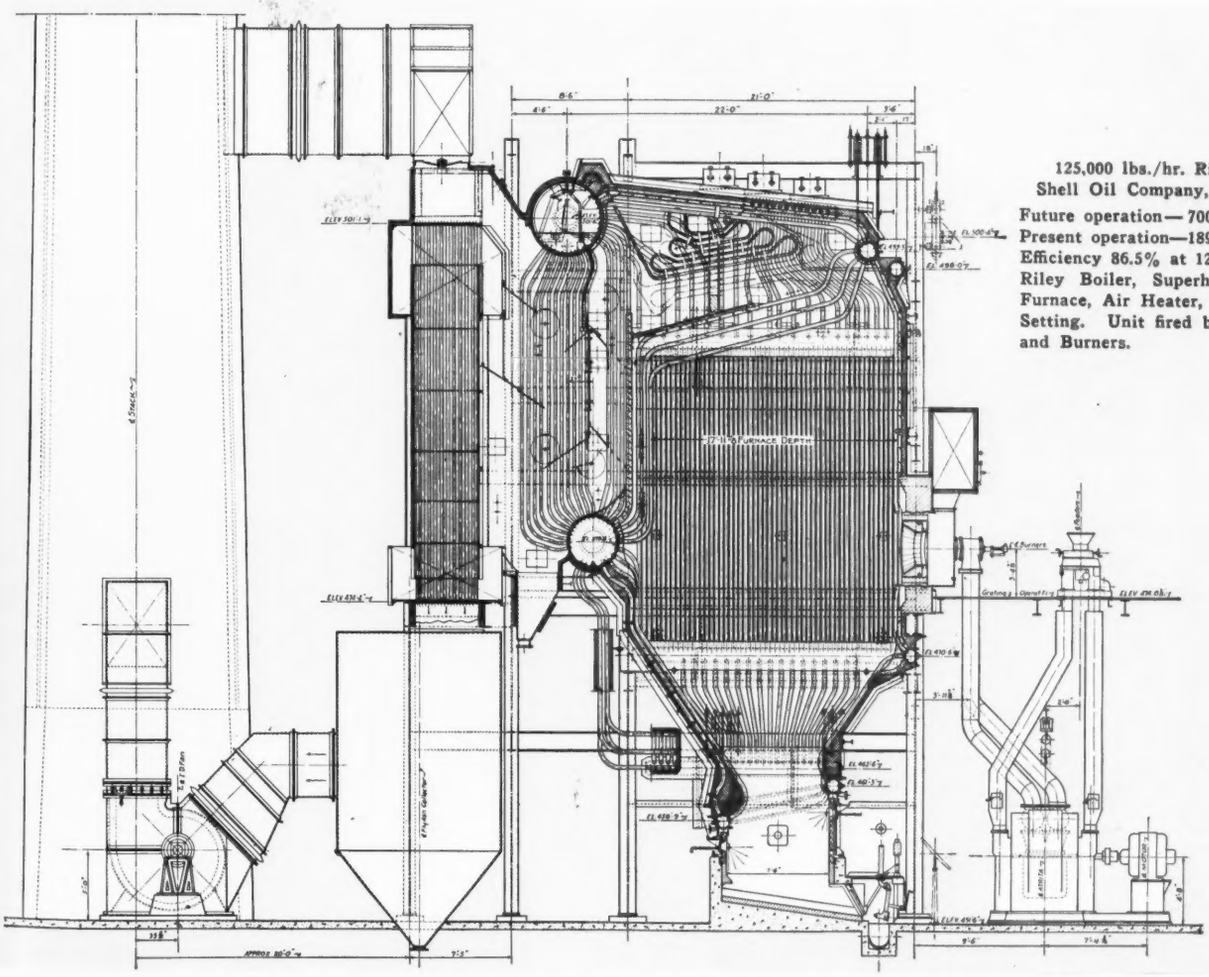
OIL OK FOR WATCHES
UNIT OK FOR SHELL

Riley is proud that Shell Oil Company, whose Golden Shell Motor Oil is O. K. for fine Swiss watches, has joined the host of industrial and central station companies who have swung to Riley equipment and found it O.K. for their power plants.

As has been the case in so many recent Riley Boiler installations, the Riley Boiler unit recently installed by Shell Oil Company at their large Wood River, Ill. refinery, is operating in excess of guaranteed performance—actual efficiency is 86.5% as against a guarantee of 84.8%; air heater exit gas temperature is 331°F. against 350°F. guaranteed. Again positive proof of the plus values in Riley Units.

When Riley installation after installation operates at higher efficiency and capacity than guaranteed, it must be perfectly evident that with Riley equipment there is no cutting of corners — that the purchaser certainly gets his money's worth from Riley.

A thorough investigation of recent Riley Boiler installations will definitely establish the superiority and greater value of Riley equipment.



125,000 lbs./hr. Riley Boiler Unit
Shell Oil Company, Wood River, Ill.
Future operation— 700 lbs. 750°F.
Present operation—189 lbs. 609°F.
Efficiency 86.5% at 125,000 lbs./hr.
Riley Boiler, Superheater, Water-cooled Furnace, Air Heater, Steel-clad Insulated Setting. Unit fired by Riley Pulverizers and Burners.

A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

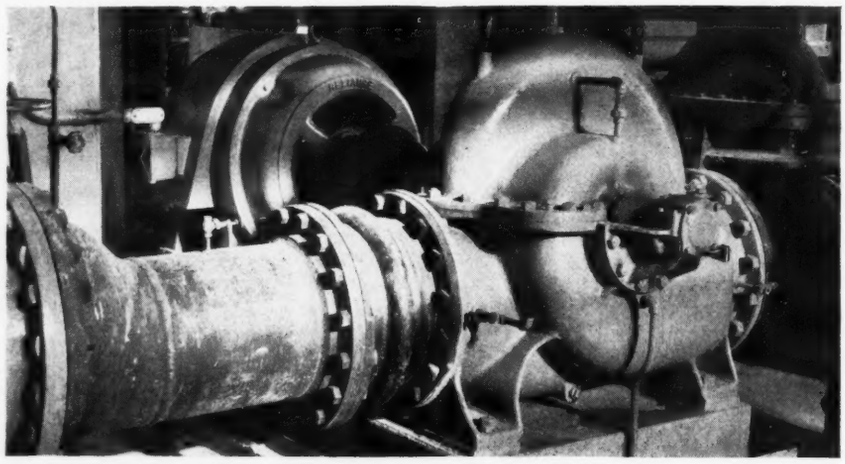
before purchasing Boiler or Fuel Burning Equipment

Southern Pine Hits the Front Page

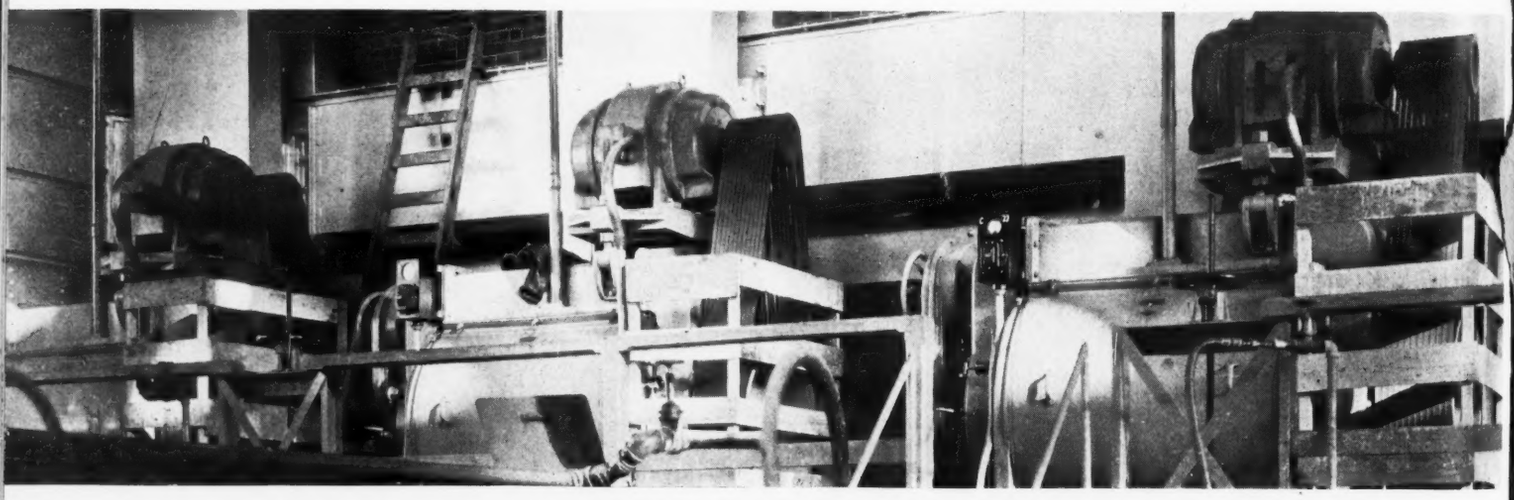
(Continued from page 91)

South is prepared to, and can, grow a pine tree in 20 to 25 years. Thus, with scientific reforestation, a solid, permanent industry is in the making—a newsprint mill can be set down in the middle of an area to make paper indefinitely from pine grown on this area.

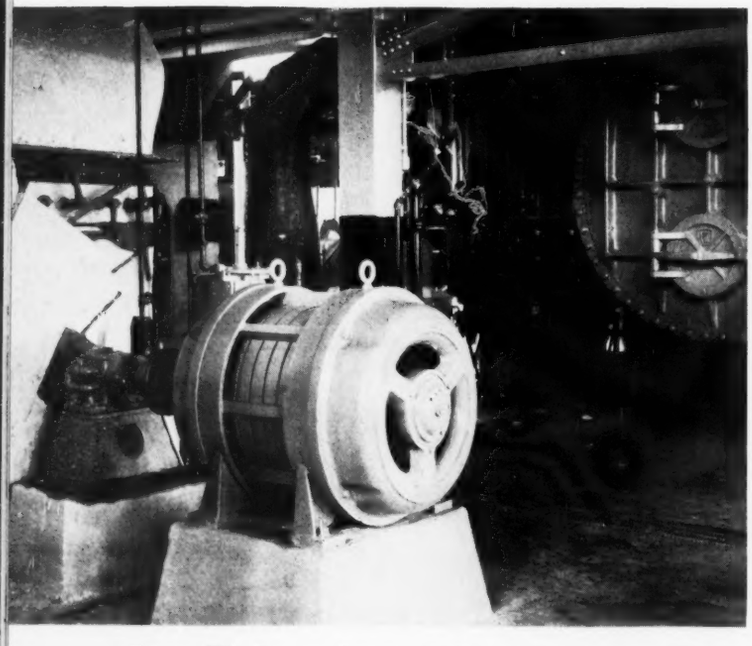
Shown on these two pages are a few of the many services power performs at Southland — driving paper machines, dryers, grinders, beaters, etc. Three 76,000-lb-per-hr Foster Wheeler boilers generate steam at 600 lb, 750 F, for two 6000-kw, automatic-extraction General Electric turbine-generators.



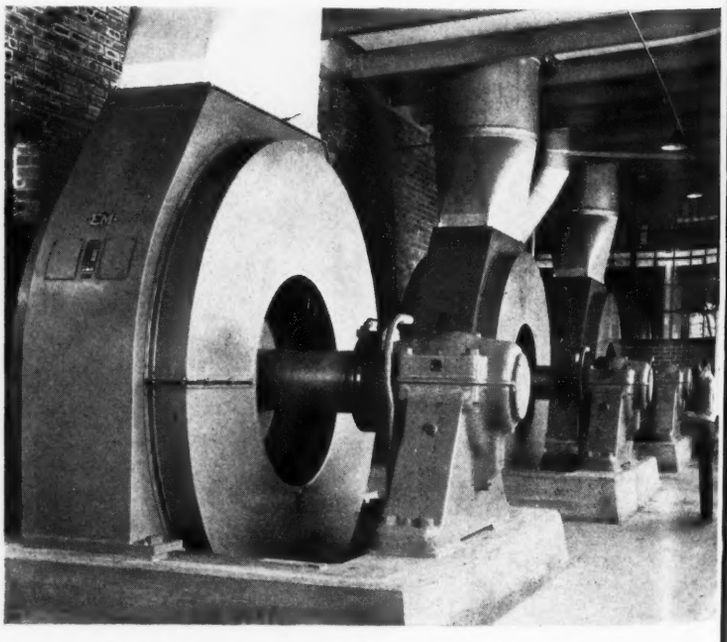
Condenser circulating pump, 8000 gpm at 75-ft head, coupled to 150-hp motor



Three pulp screens, multiple-V-belt driven from 40-hp, 1160-rpm, splash-proof Reliance motors



Foster Wheeler condenser (right) and American Blower fan powered by 125-hp, 1165-rpm, squirrel-cage Reliance motor



Three 4000-hp, 200-rpm, self-ventilated, synchronous Electrical Machinery motors are direct-connected to pulp grinders

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

NEATEST TRICK OF THE MONTH

A recent Readers' Problem question on oil-tank heater troubles brought in a slew of answers, showing widespread interest. Then along came H M Naylor with this blow-by-blow story of installing a new heater without losing a drop of oil, so we figured it rated the front page

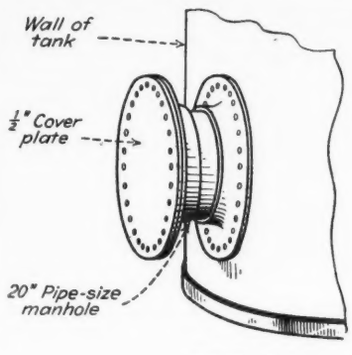
New outside heater is easily accessible for cleaning or repairs

HAVING FAILED TO READ the February issue of POWER closely because of illness, I entirely missed MM's oil-tank-heater troubles. This may be a bit late, but here's an oil-tank-heater story that should make his hair curl.

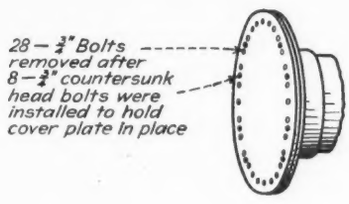
First Resort

During the early summer of 1938 we discovered oil running from the heater-coil-trap discharge on our 10,000-barrel emergency oil-storage tank (our normal fuel is natural gas). That, of course, meant a leaking coil. To reach the coil for repair meant emptying 350,000 gal from the tank and since no other storage facilities were available, we rented 35 10,000-gal tank cars and pumped the oil into them. I pass up hastily the ordeal of handling and storing 35 tank cars on an extremely modest plant track layout with a 20-ton locomotive barely able to handle three loaded cars at once. It was a nightmare and for months afterward I shuddered every time I saw a tank car.

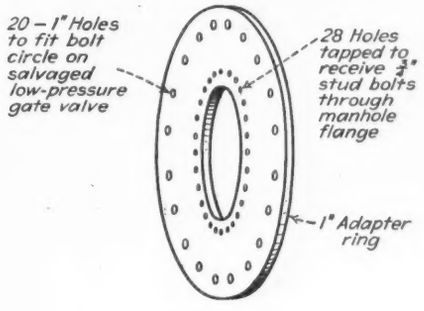
Once the tank was empty we faced the real problem. The heater consisted of four nested helical coils, only the



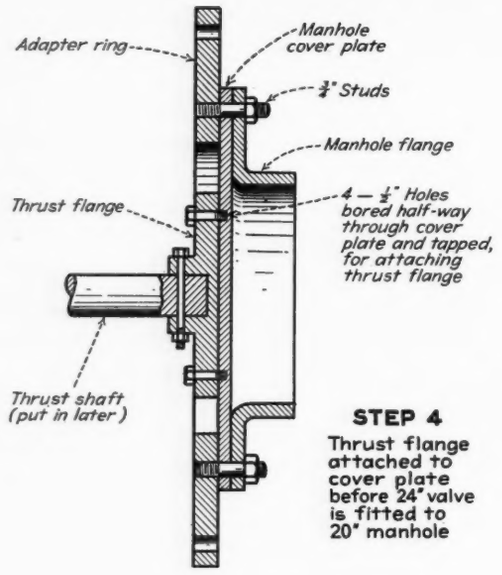
STEP 1
The starting point



STEP 2
Flange bolts removed to receive adapter ring

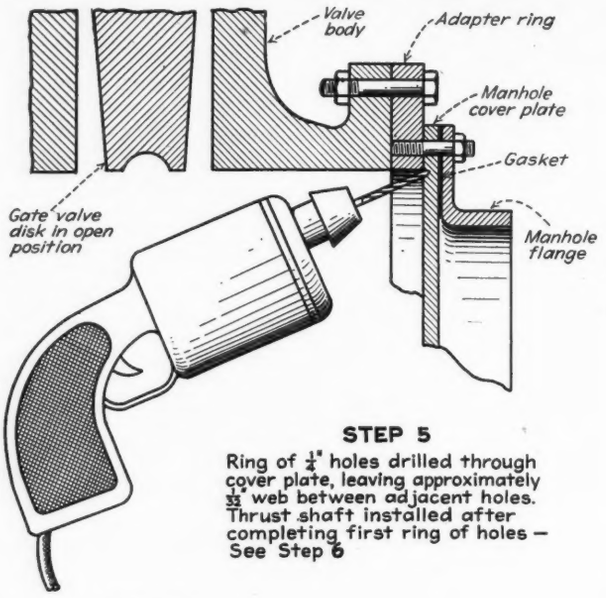

20 — 1" Holes to fit bolt circle on salvaged low-pressure gate valve
28 Holes tapped to receive ¾" stud bolts through manhole flange
1" Adapter ring

STEP 3
Adapter ring to permit fitting 24" valve to 20" hole


Adapter ring
Manhole cover plate
¾" Studs
Manhole flange
Thrust flange
4 — ¾" Holes bored half-way through cover plate and tapped, for attaching thrust flange
Thrust shaft (put in later)

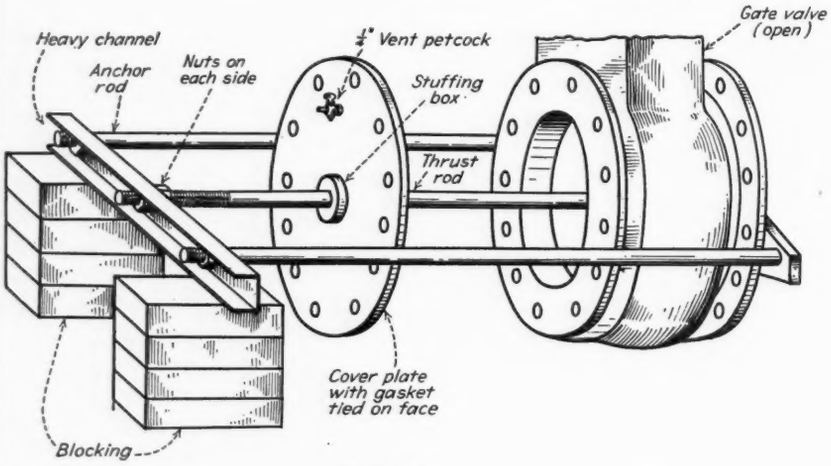
STEP 4

Thrust flange attached to cover plate before 24" valve is fitted to 20" manhole



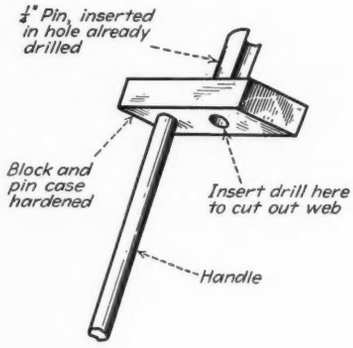
STEP 5

Ring of ¼" holes drilled through cover plate, leaving approximately 1/32" web between adjacent holes. Thrust shaft installed after completing first ring of holes — See Step 6



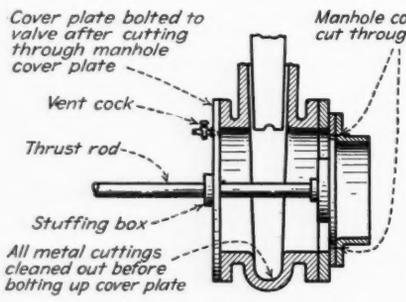
STEP 6

Thrust rod inserted in thrust flange to take hydrostatic pressure when cutting through manhole cover plate



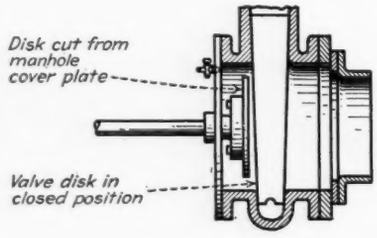
STEP 7

Webs in first row of holes drilled out using template shown above


Cover plate bolted to valve after cutting through manhole cover plate
Manhole cover plate cut through here
Vent cock
Thrust rod
Stuffing box
All metal cuttings cleaned out before bolting up cover plate

STEP 8

Manhole cover plate cut through, cover plate on valve bolted up, vent valve opened. Inside nut on thrust rod slacked off, allowing oil pressure to force disk cut from manhole cover plate away from gasket. Vent closed as soon as oil runs out. Thrust rod pulled clear back against valve cover plate before closing gate valve.



STEP 9

With valve closed, cover plate, anchor rods, thrust rod, etc, removed from valve. Valve cover plate, with stuffing box removed and hole plugged, formed cover plate on heater shell. Stuffing box and another like it took care of steam and condensate to the heating coil.

smallest of which would pass through the 20-in. manhole (the coil was installed before the tank roof was put on). They were all made up with screwed fittings—a mistake, I know, but there they were—most of which, especially the unions, were loose. Time and expense necessary to clean and purge the tank (did you ever pay rent on 35 tank cars?) barred welding the coils inside the tank or cutting a hole to remove the coil. So we did the best we could with a bunch of pipe wrenches, cleaned out the sludge, returned the oil *and got rid of the tank cars.*

We were none too well pleased with the job and confidently expected, sooner or later, to renew our acquaintance with tank cars. So when late last summer oil appeared in the trap discharge again we were not surprised. In the meantime, the master mechanic and I had

cooked up a stratagem which promised an accessible heating coil *and no more tank cars*. At the time, the tank held 300,000 gal. We proposed to abandon the old coil, and install a new one in a lock chamber, all without removing the oil from the tank.

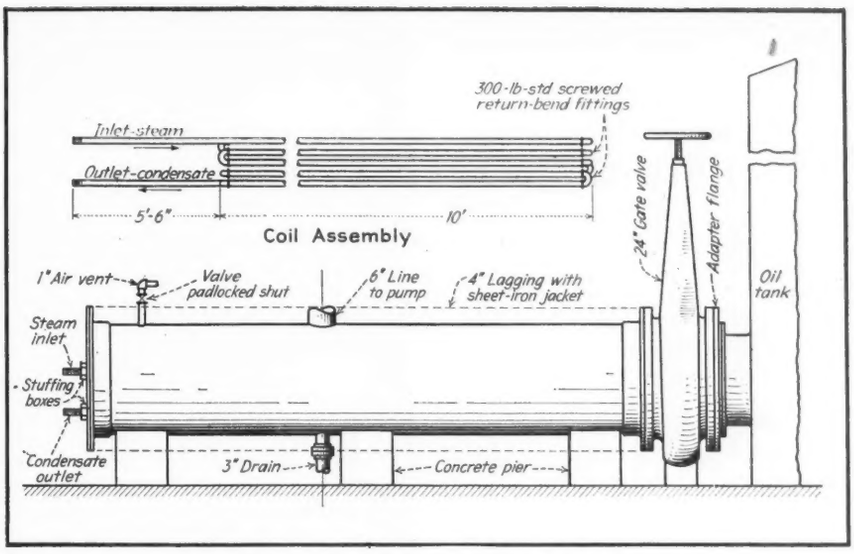
Search of salvage stores and the plant junk pile turned up a 24-in. low-pressure gate valve and a 1-in. steel disk suitable for making an adapter flange. The heater shell and cover plate were made locally of second-hand boiler plate. We bought the necessary pipe and fittings for coil, suction, etc.

Finishing the Job

Then began a careful step-by-step process to attach the adapter flange, mount the valve, and cut out the old manhole cover plate. These manipulations are shown chronologically in the sketches numbered from 1 to 11. Once the manhole cover was cut out and the rigging dismantled, the rest of the job was easy. Details of the coil, lock chamber, and piping connections are shown in the working drawing, and the photo shows the finished job, covered with 4-in. of magnesia block to protect against the weather.

It will be seen that we finally made the coil with screwed fittings; however, no unions (as in the abandoned coil) were used. Installing 300-lb-std return bends allowed us to screw up the pipe very tightly. Since the coil was completely accessible at any time there was no need to go to the more expensive all-welded construction.

As originally planned and built, the pump took suction from the bottom of the heater shell, but experience showed we could only get cold oil, as the rapidity of circulation in and out of the heater greatly exceeded expectations. We changed the suction to the top and operation was satisfactory. The heater went into service late last October and gave excellent results this past winter, even during cold ranging from −10 F to +10 F for a week at a time.



Assembly drawing of heater shell and tube bundle

✦ ✦ ✦

How to Repair a Blistered Boiler Shell

What is the difference between a blister and a bulge on the shell of a fire-tube boiler? How are they caused and how repaired? Here are the answers

By HARRY M SPRING

BOILERS BULGE if they do not get proper care and they may also blister, but from a different cause. Bulging can be prevented by keeping the boiler clean, but a clean boiler may blister.

If a boiler is not kept clean, scale, oil or other internal deposits may insulate the metal in certain parts from the water. When these parts are exposed

Fig. 1—Photograph of a section of laminated (blistered) plate cut from a fire-tube boiler shell

to radiant heat of the fire, they may become so weakened from high temperature that the internal pressure causes the metal to bulge outward. This condition affects the entire thickness of the plate.

A blister is caused by a slag deposit trapped in the ingot from which the plate is rolled. In the rolling process the slag flattens out into a thin layer between two thicknesses of the metal, Fig. 1, so that one is more or less insulated from the other.

It is almost impossible to detect a layer of slag in a plate by practical methods. X-ray examination of the whole plate would probably reveal the defect, but the cost of this inspection cannot be justified particularly on medium-pressure boilers. Furthermore a blister is rarely encountered and improved methods of steel-plate making have also reduced the possibilities of a laminated plate.

Unless the laminated area of a plate is exposed to radiant heat of the fire it probably will never be discovered. If it is in a high-temperature zone, such as over the fire in a fire-tube boiler, the slag may sufficiently insulate the exposed area of the plate over it to cause overheating. Then the outer layer separates from the inner, Fig. 1, and may burn out entirely. To reach this condition may require several years, but before this happens, surface cracks radiating outward from the center of the lamination will indicate location of the fault.

How to Repair

How to repair the defect will depend upon the thickness of lamination and other conditions. When the outer lamination is thin and extends over a small area only, remove the lamination to solid metal over the defective area and the boiler is ready for service again. If the defect extends over 4 in. along the length of the boiler or the reduction in thickness is 25% or more, then a repair is necessary, or the pressure on the boiler must be reduced to a safe value. Such repairs should be attempted only under the supervision of state and insurance boiler inspectors.

Repairs by welding are not permitted in code states and should not be attempted in any case. A properly designed riveted patch is the correct repair. Have this patch laid out by an authorized boiler inspector, a requirement in Code states, as it involves calculations that directly affect the safety of the boiler.

Removal of the defective area is the next step. A section of plate is cut out in a semi-circular or diamond shape. These two shapes permit locating the seams of the riveted patch as close to the direction of the girth seam as possible for highest strength.

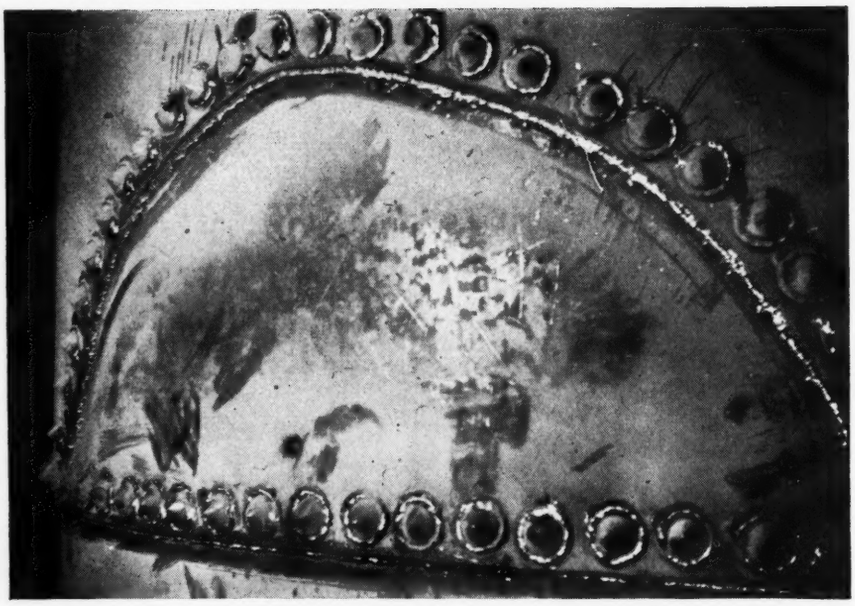


Fig. 2—Patch riveted into boiler shell to repair plate damaged by blister

Have the patch fabricated of open-hearth, firebox steel by an authorized boiler shop, preferably by the builder of the boiler. Select the thickness and tensile strength of the patch plate the same as that of the shell plate being replaced. Rivet holes are drilled in the patch plate. These are often made the same diameter and pitch as the girth seams in the boiler, but always as laid out by the inspector.

Place the patch inside and overlapping the boiler shell (Fig. 2), unless the blowdown line is included in the patch, so that sediment can flow freely to the blowdown line. When the blowdown line connection is included in the patch, place the latter outside the boiler shell. If the patch crosses or includes a girth seam, scrape down the outside edges of the patch plate so that they will tuck into this seam neatly, to prevent exposing an excessive thickness of plate to high temperatures.

Driving the Rivets

After fabrication and drilling, place the patch plate in position and drill the shell plate in alignment with the rivet holes in the former. Next comes driving the rivets. Modern horizontal firetube power boilers, 48 in. or over in diameter, have a manhole in the front head below the tubes. Even then it is often necessary to remove a few of the lower tubes to provide adequate room for a man to hold on rivets on the inside. In the absence of such a manhole, it may be necessary to remove a lane of tubes down through the boiler from the upper manhole to permit riveting the patch. Sometimes where a handhole is provided in the front head below the tubes, it is possible to fabricate a special holding-on tool with which to do the riveting.

After the patch seam has been drilled, and the patch is in position, driving the rivets comes next. Caulking the edges of the shell plate against the patch follows where the customary inside patch is used. If the patch is outside because of an included blowdown line, bevel and caulk the patch plate against the shell plate.

Testing

Check the safety and effectiveness of the patch by a hydrostatic test of 1.5 times the maximum allowable pressure, based on design of the boiler and patch, and on condition of the boiler.

After the patch has been installed in an approved manner and the repair has shown no indications of distress or leakage under hydrostatic test, the caulking edges of the plate and rivet heads may be seal welded. This is usually done by a single bead of electric welding made at normal current and fairly rapid speed or at slightly reduced current at more conservative speed. The idea is to produce a sealing bead that does not require enough heat in application to change the physical properties of the metal appreciably. In the calculations this bead is assumed not to add anything to the strength of the patch. Fig. 2 shows a completed patch, seal welded and ready for service.

Get the "Inside Story"
BY FURNACE SNAPSHOTS

A simple camera and a little ingenuity will produce workmanlike pictures to check behavior of stoker coals, diagnose pulverized-coal flames, or compare firing methods

By REYNOLD ATLAS

READING ABOUT revolutionary new developments in furnace photography must make many power engineers wish it all wasn't so complicated and expensive as it seems to be. Well, it needn't be—a simple camera and a little ingenuity are all anybody needs to make a start toward getting "the inside story" on furnace operation.

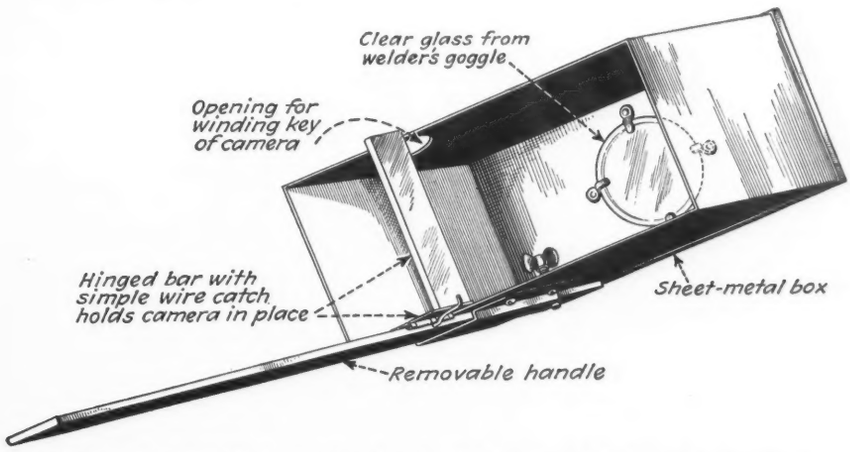
In lots of ways—no need for special lighting, for example—furnace photographs can be taken with less trouble than many other indoor shots. The gadget I use to protect my camera, a No. 120 Kodak taking pictures 3¼ x 4¼ in., appears in the sketch below. It's nothing more than a tin box, open at the back and fitted with a peephole in front. I cover the peephole with a clear welder's goggle glass. The handle on the box, and a fairly long cable release, make the outfit a little easier to handle. The hinged bar in the back keeps the camera from falling out of the protective box.

To take a picture, "set" the camera and put it in the box. Hold the box in the furnace door or opening and point it in the desired direction. Snap the picture and pull the box out before it overheats. That's all there is to the whole business, except the little matter of "setting" the camera.

An exposure meter helps but isn't necessary—I've taken all my pictures without one. Figure on wasting a few rolls of film in experimenting and then you'll be all set. I find, for example, that a lens opening of *f*11 and a shutter speed of 1/50 sec will take most flame pictures. For cooler surfaces such as walls, tubes, or slag, use a slower speed or larger opening. I get good results with Verichrome film, and haven't used a filter.

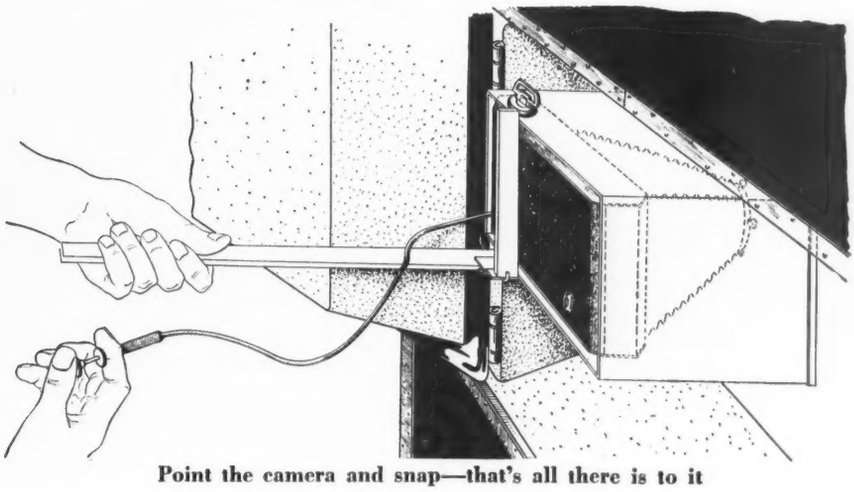
Many Uses

Easily taken furnace pictures can be put to many uses around a power plant. Study them to diagnose ignition, distribution or interference troubles in pulverized-coal flames. Compare stoker shots to check behavior of different coals on the fuel bed—no need to try to remember how that last shipment burned, the photos will tell the story! Try using pictures to show operators right and wrong methods of firing. Above all, don't forget that a picture tells more than a thousand words and that it might convince the boss easier than any other facts or figures.


Clear glass from welder's goggle
Opening for winding key of camera
Hinged bar with simple wire catch holds camera in place
Sheet-metal box
Removable handle

A tin box, with welder's goggle glass in the front peephole, protects camera

Product of the "tin-box technique", this picture shows slag conditions on a tube bank and can be used for comparison with later pictures showing development of the slagging



Point the camera and snap—that's all there is to it

PRACTICAL AIDS TO OPERATION

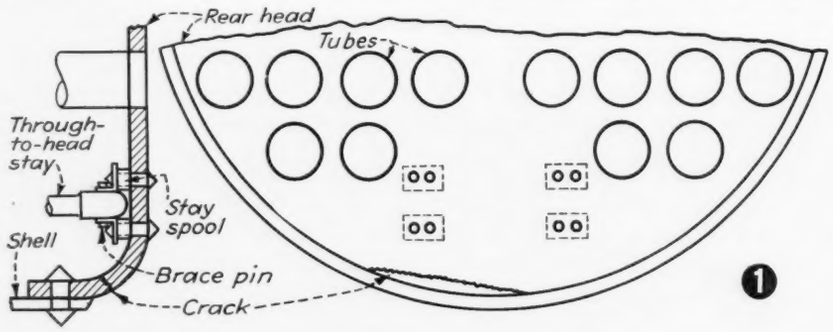
How to Repair a Cracked Boiler Head

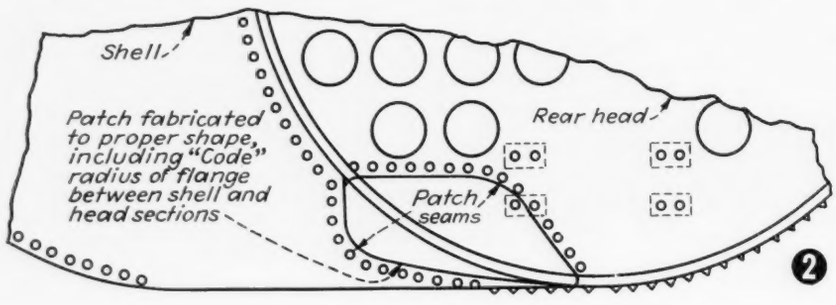
THE PHOTO SHOWS scale accumulation that caused a crack in the lower part of the rear head in an hrt boiler. This crack extended for about 12 in. and penetrated the entire thickness of the head, Fig. 1. Repairs by welding were not permitted by the State boiler rules because welding is not considered desirable or safe except in fully stayed areas.

To make the repair, the defective section of the head was cut out in triangular form, with the intention of installing a riveted patch overlapping the inside of the head and attached to the shell by new head-seam rivets. When the head-seam rivets were removed we found that the end of the shell had been overheated and the rivet holes badly distorted. It was decided then to cut back the shell to remove the defective part of the head seam. It was important not to cut back too far or the angle of the patch seam would deviate too far from the direction of the head seam. This would produce an undesirable and weakening effect.

Fig. 2 shows the installation of the patch. After completion of the riveting and caulking, a hydrostatic test pressure of 1.5 times the allowable pressure on the boiler was applied. No indications of leakage or defects developed. A seal weld was then applied to the caulking edges to provide additional assurance against leakage.

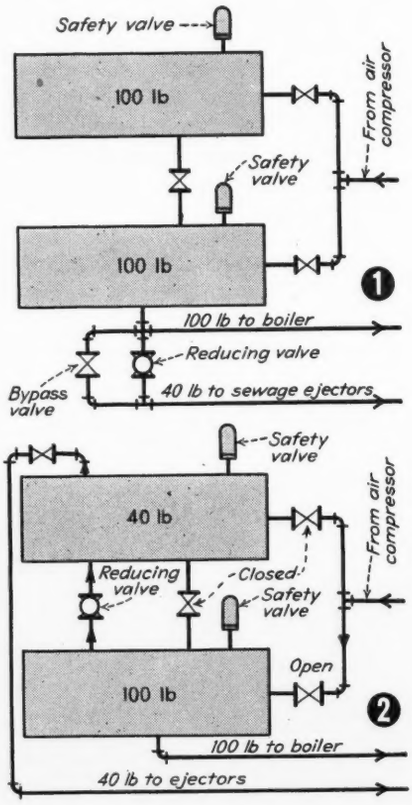
Canton, Mass. HARRY M SPRING




Shell
Patch fabricated to proper shape, including "Code" radius of flange between shell and head sections
Rear head
Patch seams
2

Piping Change Improves Valve Operation

FIG. 1 SHOWS HOW the compressed-air system was connected in our plant. Air at 100-lb pressure was stored in two receivers from where it was taken to the boiler for cleaning. 100-lb air was also taken through a reducing valve and dropped to 40 lb for operating two sewage ejectors. We had trouble with noisy operation of the valve and pressure sometimes built up high enough to collapse the floats in the ejectors.



To eliminate these difficulties I changed the piping connections, Fig. 2. This converted one of the 100-lb receivers for storage of 40-lb air. The reducing valve now does not have a large pressure drop across it. Neither is it called upon suddenly to supply the

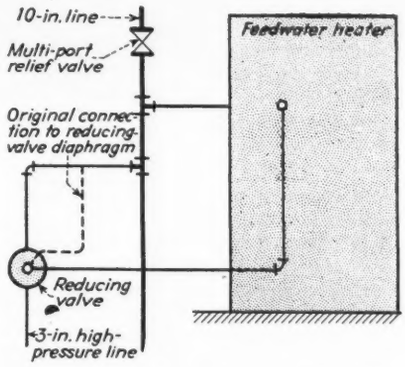
whole volume of air required to operate an ejector. As a result, the valve operates quietly and we have no more trouble with floats collapsing.

New York, N. Y. JOHN PLATT

Change in Pipe Holds Feedwater Temperature

WE FOUND IT DIFFICULT to keep feedwater temperature at 215 F in our feedwater heater when load was heavy. Heating was done with some exhaust steam supplemented by live steam controlled through a valve that reduced boiler pressure to 3 lb.

The 3-in. reducing valve is connected by about 6 ft of 3-in. pipe into a 10-in. line that goes into the heater, see diagram. Originally the reducing-valve diaphragm connected to the 3-in. line about 4 ft from the valve on the low-



pressure side. Pressure on the 3-in. line held up, but during heavy loads expansion into the 10-in. line and then into the heater caused the pressure to drop to zero.

To correct this difficulty we connected the line from the diaphragm to the steam compartment of the heater, as shown.

Rochester, N. Y. H P KING

Tight Plugs for Condenser Tubes

When a hole occurs in a condenser tube usual practice is to plug the tube. Plugs made of wood leak because the wood is porous. Because there is no taper in the tapping of a condenser tube sheet, screw plugs depend upon thread tightness and frequently leak. Nonferrous metal plugs used to stop up tubes must be driven in by hand, are difficult to remove and tube holes may be enlarged and injured.

Plugs made from solid fiber have many advantages to recommend their use. They do not damage the tube sheet since a light tap with a hammer drives them into position; they swell in water and make a tight fit in the tube; they are reliable and are easy to remove.

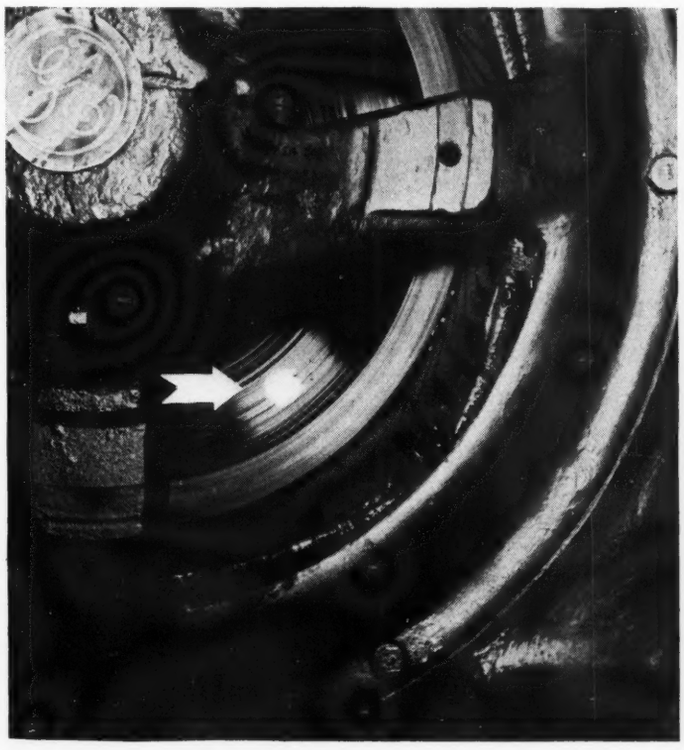
Hoboken, N. J. W M KENNEDY
Condenser Service & Engr Co

Neon Lamp Guides Frequency Control

IN OUR POWER PLANT we have two 300-kw dc-generators from which ac power is supplied by a motor-generator set. A limited-capacity emergency ac connection is taken from the utility line. Several clocks in the plant are on the ac lines from the motor generator set, making it necessary to maintain constant frequency. By mounting two clocks together, one connected to utility power and the other to our ac generator, we could adjust speed of the motor-generator set to maintain its clock in step with the other. This, however, required considerable time to compare one clock with the other.

To overcome this difficulty, we connected a neon lamp to the outside power source and reflected it on the revolving field poles of the ac generator. If the two frequencies are the same, the field poles appear to stand still; if too high, poles appear to move forward; and if too low, they seem to move backward.

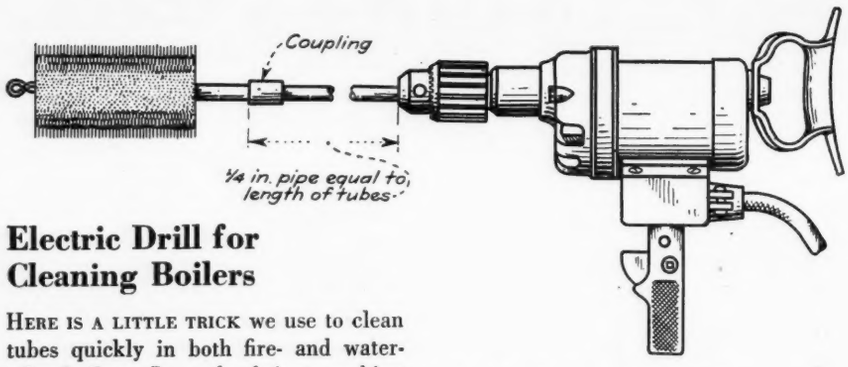
In trying to find the best location for the lamp, we discovered that if it were placed on one side of the motor, as at *A* Fig. 2, so that its light could shine through between the poles, a bright red disk could be seen at times on the other side, Fig. 1, when the motor was revolving at proper speed. High or low



frequency caused a shadow to pass across the light in a direction depending upon the frequency. When the frequency is correct the light can be seen constantly bright or dark depending upon the angular position of the field poles.

To make it easy to see the light we placed a mirror to bring it to eye level. This device is working very satisfactory and the material in it cost less than $3.00, including the lamp.

St. Louis, Mo. C H HERR
Chief Engr, Excelsior-Leader Laundry



Electric Drill for Cleaning Boilers

HERE IS A LITTLE TRICK we use to clean tubes quickly in both fire- and water-tube boilers. Instead of just pushing the brush through the tubes we connect it to a slow-speed electric drill by a section of ¼-in. pipe of a length equal to that of the tubes we are going to clean.

We enter the brush into one end of the tube, start the drill and push the brush through to the other end. In some cases we put a small universal joint in the middle of the pipe to make it easier to handle. This method has proved far more effective than the conventional one of just pushing the brush through the tube and it also does a surprisingly better cleaning job.

Englewood, N. J. R BOETTINGER

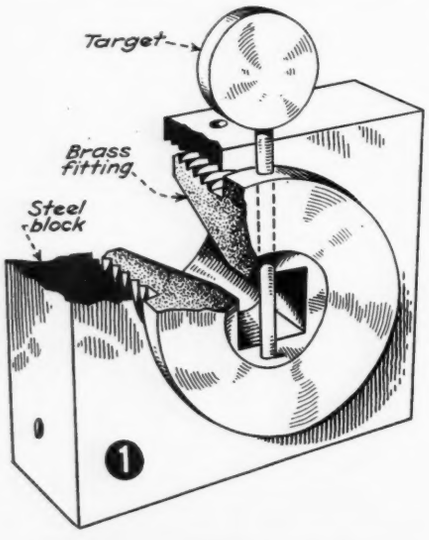
Safety Lock for Elevator Doors

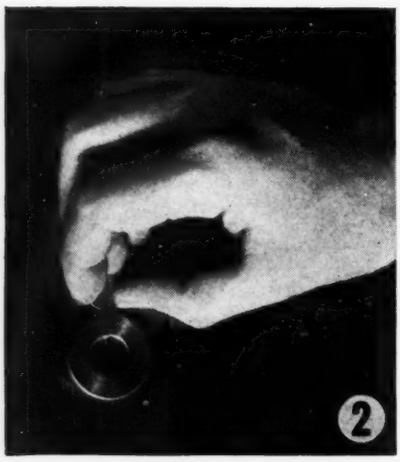
JUST WHY ANYONE would use a key to open the bottom landing door on an elevator and not make sure the car is there before he steps into the hoistway is difficult to explain. However, such accidents occur often enough to cause concern to those in charge of elevators. Much thought has been given to preventing these accidents and several methods have been developed. In our building, we made a device (Fig. 1) that is attached to the elevator hoistway door where the key goes through to lift the locking bar.

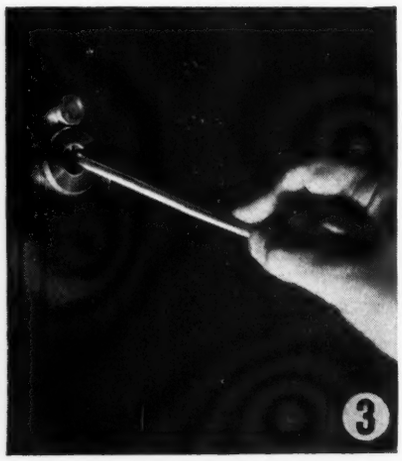
This device consists of a steel block that goes inside the outside sheet of the door. A brass fitting with the keyhole in its center threads into the steel block and locks it to the door sheet. A hole drilled down through the flange of the fitting holds a tight-fitting pin with a target that can be inserted or removed with the fingers, Fig. 2. The pin is in the hole at all times, to prevent inserting the key, Fig. 3, until the target is removed, which requires some effort. When the car is in regular service or is left at the ground floor, a brass target is used. If an idle car is taken away from the floor the brass target is replaced by a red one as a reminder that the car has been taken away from the floor.

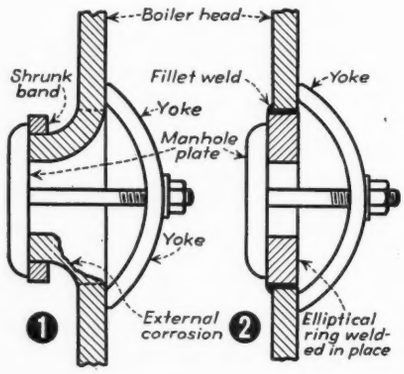
This device is not 100% safe, but it does put another obstruction in the way of opening the doors and also warns that the car may not be at the floor, which should be sufficient to remind anyone that he is to open the doors with care.

New York, N. Y. WM DEVAUGHN
Elevator Engineer
40 Wall Street Building





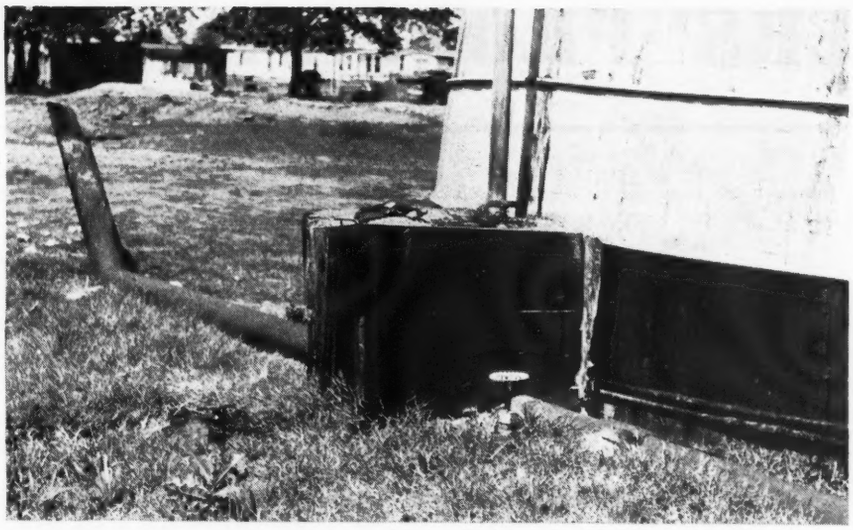




Improper Repair Causes Boiler to Be Scrapped

A FLANGED-IN MANHOLE in the flat head of a firetube boiler was repaired recently in such a manner that the boiler was made unsafe for continued operation at high pressure. Fig. 1 shows the effects of corrosion on the external surfaces of a manhole frame. To repair the defect, the plant engineer cut out the manhole and placed an elliptical ring about $\frac{3}{16}$ in. thicker than the boiler head in the opening so that the external surfaces were flush. A fillet weld was then run around the shoulder on the inside, Fig. 2.

Dimensions of this repair were such that the manhole plate bore directly on this ring, so that the stress due to pulling up the manhole nut plus pressure of the steam combined to produce a



Sand Box Prevents Valve Freezing

AT OUR PLANT the exhaust line from a gas engine runs out of doors near the valve on the water-supply line. There was danger of this valve freezing in cold weather during week-end shutdowns. Consequently, we built a large box to inclose the valve and a section of the exhaust line, see photo. We filled the box with sand and put on a tight cover to keep it dry.

Now, heat from the exhaust line is gradually stored in the sand, maintaining temperature around the valve well above freezing even in zero weather. When the engine is shut down there is sufficient heat stored in the sand to prevent the valve freezing during week-ends.

Kilgore, Texas C C LYNDE

load of 44,000 lb total load, tending to shear the weld. Braces in the boiler were so close to the manhole that there was nothing that could be done to correct the faulty repair.

No repairs by welding on a steam boiler should be attempted unless sanctioned by an authorized boiler inspector. A safe rule to follow is: Use welding for sealing against leakage where failure of the weld will not cause rupture of any pressure part.

Columbus, Ohio J R WILLIAMS

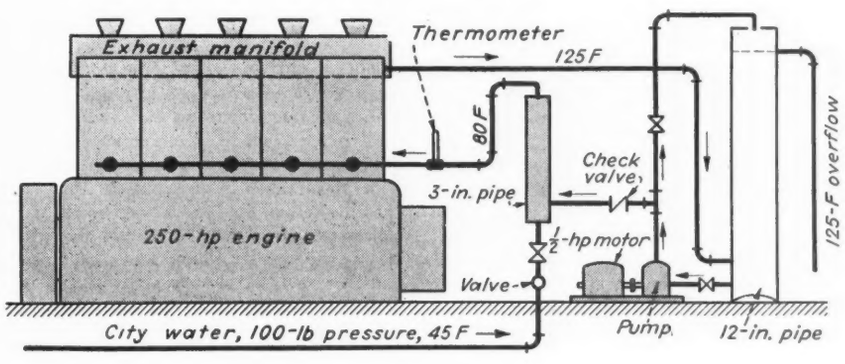
Hookup Solves Cooling-Water Problem

UP IN OUR COUNTRY it gets pretty cold in the winter and water from the city lines for cooling our 250-hp diesel engine comes into the plant at about 45 F, which is too cold for this purpose. To raise the water temperature to about 80 F we installed the water-heating system shown in the diagram.

We made a hot-water storage tank from a piece of 12-in. pipe and connected the cooling-water discharge pipe from the engine, near its bottom. We also made a cold- and hot-water mixing chamber from a piece of 3-in. pipe and connected it into the cold- and hot-water lines as shown. A small pump driven by a ½-hp motor recirculates a sufficient supply of the hot cooling water to maintain an 80-F inlet temperature to the engine. This is done by adjusting the valves in the water lines, to obtain the proper inlet-water temperature as indicated by the thermometer. Hot water not needed for mixing with the incoming water is bypassed to the storage tank and any excess overflows to waste.

When starting the engine after it has been standing for some time in cold weather, we close off the city water and just circulate the water in the storage tank. In this way the engine is quickly brought to a temperature where it will operate smoothly.

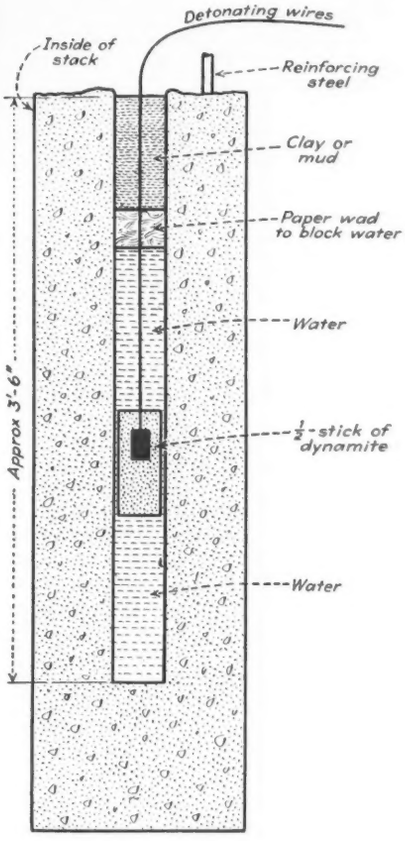
Prince George, B. C. C E FREEMAN



Dynamite in Water Shatters Concrete Stack

The drawing shows a method of shattering the concrete wall of a stack by exploding the dynamite in water, thus distributing force of the explosion over a greater wall area. On one reinforced concrete stack, poured in 5-ft sections, holes for the dynamite were drilled 3 ft 6 in. deep on 16-in. centers around the top of the stack, as in the diagram.

A ½ stick of dynamite was supported about ⅔ of the way down each hole and the holes filled about ⅔ full of water. A paper wad about 2 in. thick was placed above the water and the remainder of the hole tamped full of clay, as shown. Detonating the dynamite shattered one section of the stack at one shot.



Oklahoma City, Okla. C R WENZ

READERS' PROBLEMS

Questions from Our Readers

Coal Weighing

Question 1

IN OUR PLANT, *coal is brought out of the bunker in a ¾-ton bucket which rides on an overhead track. Our coal consumption is about 3 tons a day but on weighing some of the buckets I have found that instead of there being ¾ ton in the bucket, the contents have weighed anywhere from 600 to 740 lb. This puts a sizeable error in any calculations we make regarding coal consumption. How can we rig this bucket to weigh the coal in each load, or to indicate when it holds ¾ ton?*—LF

Alarm System for Hot Bearings

Question 2

WE ARE HAVING TROUBLE *with bearings on heavy rolls getting hot and in some cases burning out before we discover what is happening. Can* POWER *readers tell me how to build a simple device that will give an alarm or indicate when the bearing temperature reaches the danger point?* —RWO

Cleaning Soot from Boiler Tops

Answers to May Question 1

The Question

WE ARE INTERESTED *in learning of a good way to clean soot from the tops of our boilers. Have any* POWER *readers built home-made vacuum cleaners or other devices for making this job less of a nuisance?*—WHH

Protect Boiler Covering

WHH'S QUESTION opens an interesting subject. Where ashes are removed by a suction system or a steam-jet ash conveyor, these systems may be adapted to cleaning boiler tops. A connection may be run from the suction side of the conveyor to a location close to the boiler top. From this point a suction hose provides the flexibility the system needs. This disposes of the dust and dirt to the regular ash hopper where it belongs. The usual precautions must be observed, such as seeing that the explosion door to the hopper is maintained free and in good condition.

Protection of the boiler covering is another matter. This depends on the construction. Where magnesia or asbestos is used and can be affected by the suction, it must be protected. At the same time the covering is being protected, a surface can be formed which tends to keep dust and dirt from sticking. Ordinary paints cannot be used for two reasons. The paint tends to soak into the insulation, cutting down its value, and it will not stand the heat.

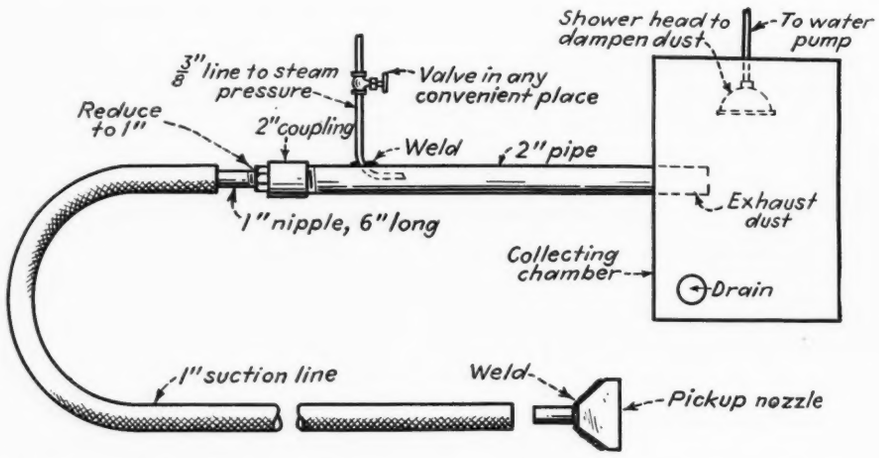
Some of the newer synthetic compounds or finishes overcome these objections. Either the glyptals or alkyds serve this purpose nicely. They form a tough protective coating that will stand heat. The use of one of these coatings is probably justified whether vacuum is contemplated or not. Where there is loose insulation, a piece of cotton cloth may be saturated with the finish and applied right over the top of the insulation. This cloth, applied before the finish dries thoroughly, tends to stick to the insulation material and keeps it in place. A second coat forms a good permanent finish. This finish may be kept clean easily, as it resists the action of both heat and moisture.

Lakewood, Ohio J P SIMONS

Simple Cleaner

PERHAPS THE IDEA shown in the sketch will help WHH; it represents a simple and useful cleaner for removing dust and dirt from boiler tops, made from scrap materials. The size of the apparatus depends on the time to be taken in cleaning. A ⅜-in. steam nozzle welded into a 2-in. pipe furnishes necessary suction. The nozzle tip points toward the outlet where a box catches the dust or soot. A shower spray then dampens and washes the mud into the drain. About one foot from the nozzle welding, install a coupling with 1x2-in. reducer carrying a 6-in.-long nipple. To this connect, by clamping, a 1-in. suction hose, carrying a welded nozzle made of flattened pipe. Hook up the ⅜-in. piping to a source of steam pressure and the free end of the hose is ready to pick up anything from a brick to a manhole plate.

Knoxville, Ill. CLINTON LAWSON



Buy a Vacuum Cleaner

ABOUT FOUR YEARS AGO in a hospital plant where I was a watch engineer, we solved the problem of removing soot and dirt from boiler tops by using a second-hand vacuum cleaner. We used to clean the boiler tops by means of a garden hose, using low-pressure water so as not to splash everything in the boiler room. This caused rust in many places where it shouldn't accumulate and we found the pipe covering falling away in several spots and had some trouble with the boiler insulation.

This method of boiler cleaning was discontinued after the Chief checked up on it, and he asked for suggestions. Someone suggested buying a second-hand compressor and hooking up an air line but this was voted down as it seemed likely to blow dust around instead of doing a good cleaning job. Then one of the watch engineers suggested a second-hand vacuum cleaner. All this idea got at first was a laugh but it turned out to be a real cure.

The Chief finally got hold of a cleaner to his liking, after looking over several "buys", and with a few minor adjustments it turned out A-1. Engine and boiler-room crews chipped in to buy the machine, as the hospital's budget wouldn't stand it. Not only did we use the machine to clean boiler tops, but we put it to work on the generator set as well. We received five cleaning appliances with the machine and found ways of using them all. With this "house-

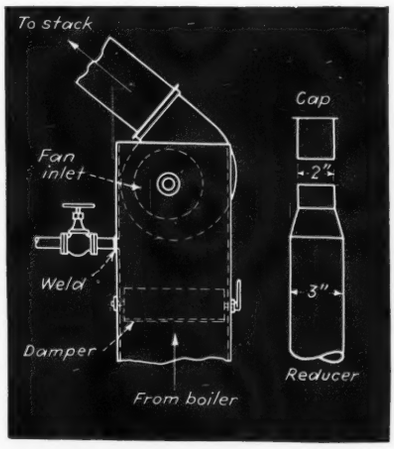
keeping" outfit we could give the boilers and both boiler- and engine-rooms a thorough cleaning in one watch where it used to take 3 by the old methods.

Philadelphia, Pa. W T MULLEN

Use Fan Suction

A FEW MONTHS AGO we devised a vacuum system to clean the tops and sides of our boilers and, in fact, any other part of the boiler room as desired. If WHH's plant is where there are flyash or smoke restrictions he could not use the system, but if he is where there are no restrictions it will serve very well.

Our suction system consists of a pipeline leading from one of the induced-draft fans to wherever we want to clean. This line we made of light-gage tin, 3-in. dia, with the ends of all branches reduced to 2 in. to allow connecting the hose of a vacuum cleaner. We welded the line to the fan housing on the inlet side, as shown in the sketch. The valve acts as main shutoff for the line. The detail in the sketch shows how the reducers were made, from the same gage tin. A cap shuts off each branch when not in use. Soldering all joints safeguarded against leaks.



To pick up the dust we got an old vacuum cleaner. We discarded the dust bag and used a light rubber hose 2 in. dia, long enough to allow the cleaner to be moved over most of the area to be covered. With the aid of the proper connections this hose was attached to the exhaust nozzle of the vacuum cleaner and to the pipe leading to the induced-draft fan. We mounted the cleaner on a baseboard and provided a handle so the cleaner unit can be moved from place to place. By providing a pickup hose several feet in length and using the ordinary attachments to pick up the dirt, WHH will find this system very flexible and he can do a good job of cleaning without a great deal of trouble.

In case WHH has no induced-draft fan and where there are no dust and smoke restrictions, he could use the vacuum cleaner by placing the discharge hose outlet through a window of the building so as to exhaust the dust to the atmosphere. When connected to the induced-draft fan as described, the action of the fan helps the vacuum cleaner by giving it a much stronger suction and the velocity of the air in the pipeline will be strong enough to keep the line from clogging. If the induced-draft-fan damper can be shut slightly when the boiler is operating at light rating, the suction to the vacuum cleaners will be increased.

Bismarck, N. D. LESLIE BRADLEY

Useful Vacuum System

THE ACCOMPANYING SKETCHES show a low-cost, serviceable vacuum system which I have applied with success in both marine and stationary practice. A terminal condulet makes an ideal suction nozzle when used as shown, with a handle of convenient length and shape, made from conduit. The jet can be led into either the breeching or ash pit as best suits the job. The distance from nozzle tip to outlet should not be less than 12-in. for best results. The correct location can be found by moving the threaded pipe in the tee until maximum results are obtained, then the lock nut can be secured.

The $1\frac{1}{2}$-in. conduit can be led over boiler tops or to the most convenient location. Air-hose cocks can be brazed into the conduit at intervals, as the job requires. The cap at the end of the conduit should have the head thickness reduced to $\frac{1}{32}$ in., to act as a relief in case steam pressure builds up in the conduit. This is, however, an extremely remote possibility.

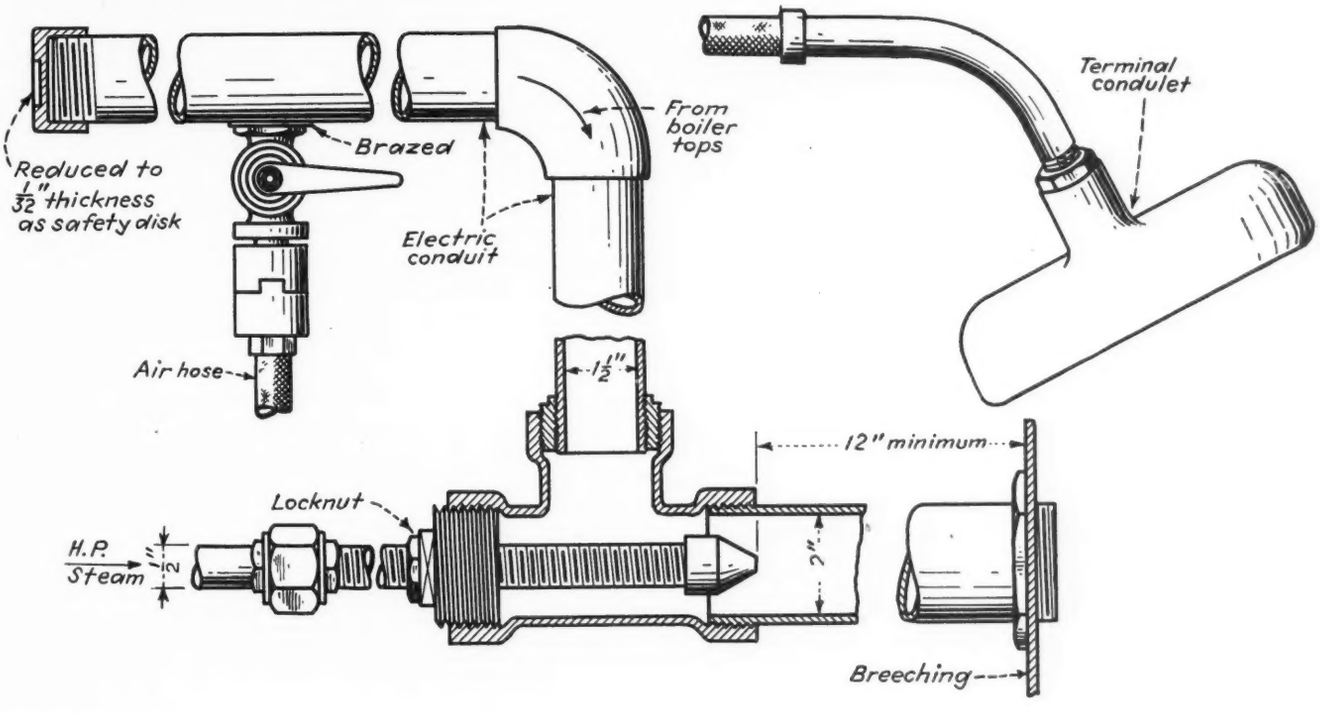
If WHH doubts the efficiency of this outfit, he may surprise himself by making a small model in his home workshop and trying it out on the domestic heating system with 5-lb steam pressure. The results will give him an idea what to expect when using high-pressure steam.

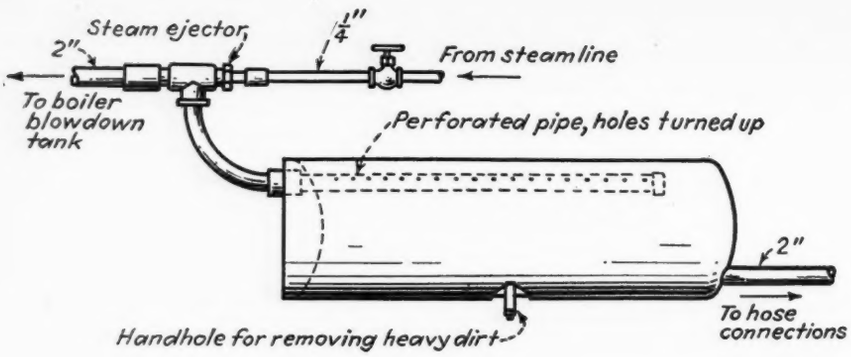
Kearny, N. J. GEORGE MCNALLY

Ejector for Vacuum

IF HIGH-PRESSURE STEAM is available, an effective vacuum cleaner can be made by utilizing a steam jet to produce the necessary vacuum. In our case, we used a commercial steam ejector, with 2-in. suction and discharge, and $1\frac{1}{4}$-in. steam connections.

For a dirt collector, we took a second-hand tank with a handhole on the side facing downward. Ejector steam and fine dust discharge into the boiler blowdown-receiving tank, vented and connected to the sewer. The ejector suction connects to a perforated pipe running along the top of the dirt-collecting tank. Suction lines consist of 2-in. pipe with conduit elbows and long-radius drainage fittings. We also used





commercial 1½-in. vacuum-cleaner hose and connections along with floor tools and rubber nozzles. The sketch shows the general arrangement.

Altoona, Pa. A R MARKLAND

Dissolving Sludge

Answers to May Question 2

The Question

WE HAVE BEEN URGED *to use various chemicals for dissolving sludge in boiler No. 6 (Bunker C) fuel oil. We have tried several but have no means of accurately checking their value and so cannot arrive at any definite opinion. Have* POWER *readers had any experience with compounds of this type, and have they been able to come to any definite conclusions as to their value?*—AAB

Dissolving or Dislodging?

IN MY EXPERIENCE with oil-fired steam boilers in the marine field, I frequently came in contact with AAB's problem—how to check the value of various chemicals for dissolving sludge in Bunker C fuel oil. However, I consider this to be a matter of "dislodging" rather than a true "dissolving" of the sludge. Beyond this, there is the question as to whether the sludge is a natural sediment of the fuel oil or formed only by the effect of preheating. Without being more definite on these points, it is difficult to give any hard and fast answer.

Troy, Ohio D AUFHAUSER

Hard to Check

AAB HAS POSED an extremely difficult question—one that cannot be answered adequately without some sort of laboratory-controlled test procedure. In an operating plant, with no way to control such variables as differences in oil characteristics, preheating temperatures, load fluctuations, etc, it is almost impossible to say that this "sludge dissolver" produces definite results and that another fails to make any difference. Of course, the experienced operating engineer will fight shy of compounds that are sold with exaggerated claims as to colossal improvements in combustion, more heating value from each gallon of oil, etc. These are akin to the old "fuel-savers" to be sprinkled on coal fires to produce anything from 50% more steam to a Republican election victory. These and similar patent medicine schemes have been thoroughly exploded.

What's really needed is a careful scientific study of sludge formation in fuel oils and extensive tests, under laboratory conditions and under controlled operating conditions, of sludge-dissolving compounds. This looks to me like a job for the Bureau of Mines or some other organization with research facilities and no "axe to grind".

Cincinnati, Ohio T D HOMANNS

One That Works

WE HAVE BEEN USING a proprietary compound which seems to give good results, as our strainers are rarely ever dirty. We burn Bunker C oil. If AAB would like to try this compound under his operating conditions, I will be glad to give him its name, and the name and address of the manufacturer.

New York, N. Y. JOHN PEARSON

Compound Saves Cleaning

FOR SEVERAL MONTHS our fuel-oil heater had to be taken apart and cleaned, at least once a month, due to a thick sludge forming on the coils and reducing the heat transfer to a point where the oil temperature dropped from 220 F to 160 F. We used a recommended treatment in the following manner: 7 lb of solution per 1000 gal. of fuel oil, circulated through the heater for several days. Now temperature can easily be maintained at 220 F with the same steam pressure on the coil. The circulating pressure was also benefited, dropping from 200 to 150 lb.

This indicates that the sludge has been removed from the coil and we have not had to remove the coil for cleaning since the treatment. If AAB is having trouble with sludge in a fuel-oil tank, I recommend that a measure of oil and sludge be taken from the tank, heated, and treated with the solution until the correct proportion of treatment is determined. I will be glad to give AAB the name of the compound, if he so desires. It can be obtained at any engineering supply house.

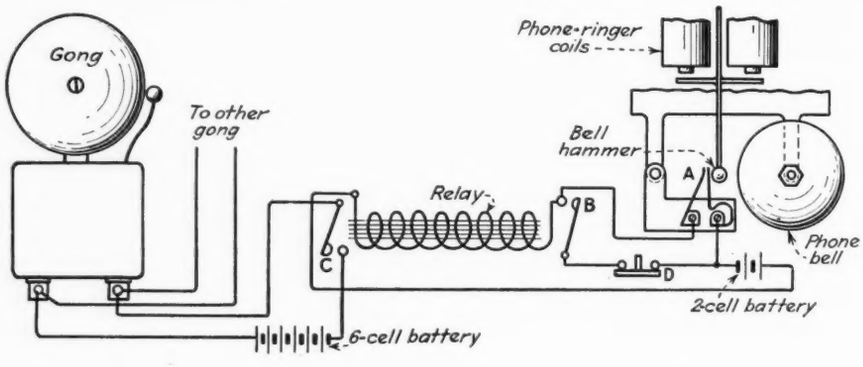
Brooklyn, N. Y. JOHN DOBSON

Telephone Ringer Operates Gongs

WE HAD THE PROBLEM of ringing two gongs where the watch engineer could hear, at least one of them, when no one was in the chief engineer's office to answer telephone calls. The diagram shows how this was done. The telephone ringer had two bells so we removed one of them and replaced it with a pair of contacts, *A*. As shown in the diagram, these contacts, located so that they are closed by movement of the ringer hammer, were connected to the coil of a double-open-contact relay through a 2-cell battery. One of the relay contacts was wired through a 6-cell battery to the two gongs, as shown in the sketch below.

Now, when a call comes in on the telephone, the first stroke of the ringer closes contacts *A* and completes the circuit through the relay coil and the 2-cell battery. Relay contacts *B* and *C* close; contact *B* completes a circuit through the relay coil and the 2-cell battery to keep the relay coil energized and the contacts closed. The gongs are energized through contact *C* and the 6-cell battery. These gongs continue ringing until someone answers the telephone and presses pushbutton *D* to break the relay coil circuit and release its contacts. This system has been in operation for several years with entire satisfaction and has cost nothing to maintain.

Chicago, Ill. V T KROPID



Measuring Brake Horsepower

By PHIL SWAIN

THE INDICATED HORSEPOWER (Ihp) of a reciprocating engine is the power delivered by the steam (or gas, in case of an oil or gas engine) to the working end or ends of the piston. Brake horsepower is the power actually delivered by the whole engine to the connected load, which may be generator, belt or brake.

We call it "brake horsepower" because it is sometimes conveniently measured by a prony brake in the manner to be described. The brake horsepower (Bhp) of an engine is always less than the Ihp by the total of various friction losses of the engine. Generally the Bhp runs from 80 to 90% of the Ihp, which is just another way of saying that the "mechanical efficiency" runs from 80 to 90%.

Fig. 1 shows a very simple prony brake, a double loop of rope running around a pulley or flywheel, with a

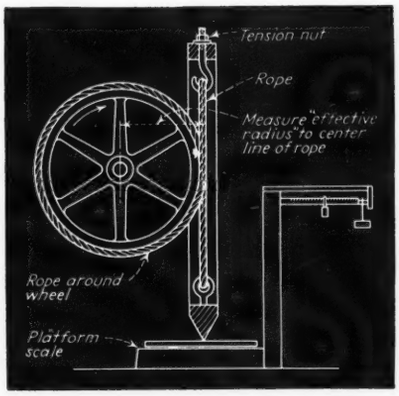


Fig. 1—Ultra simple prony brake. Effective radius of action of force (same as lever arm) is from center of wheel to center line of rope

threaded hook and nut to tighten the rope. The frame holding the ends of the rope bears directly on platform scales. To operate, tighten the nut to put the desired load on the engine, then balance the scales. Measure the engine speed. Radius of action of the force is measured to the center line of the rope. No other data is necessary.

The radius is measured to the center of the rope, rather than to the rim of the wheel, because the brake acts as if the rim of the wheel were tangent to the center line of the rope, that is,

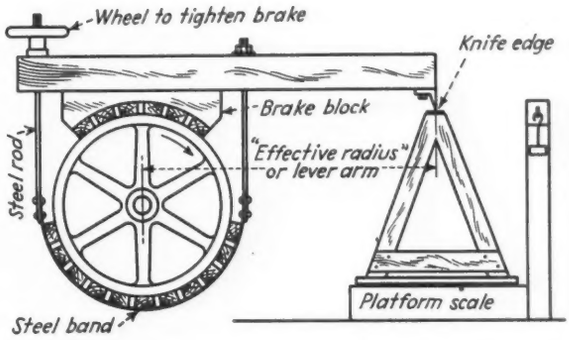


Fig. 2 — Common form of prony brake. Radius of action of force is measured horizontally from center of wheel to vertical line of action of force

to the line through which the force is transmitted vertically to the scales. This distance may be called the "effective radius" or the lever arm.

The reading of the scales may then be looked upon as a force dragging on this imaginary wheel.

Now, when a body is moved against a force, the work done, in foot pounds, is simply the number of feet traveled, multiplied by the force, in pounds.

To make this clear, let's assume a brake test in which the wheel diameter is 26-in., rope diameter 1 in., engine speed 165 rpm, and the force on the scales 128 lb. Then wheel radius is 13 in. Adding half the rope diameter we get 13.5 in. effective radius. Divide this by 12 to get the radius in feet, $13.5 \div 12 = 1.125$ effective radius.

The circumference of any circle is $2 \times 3.1416 \times$ radius, so the effective circumference of the pulley will be $2 \times 3.1416 \times 1.125 = 7.0686$, say 7.07.

The engine is turning 165 rpm, so the distance travelled in one minute is $165 \times 7.07 = 1166.55$ ft. Call it 1166 ft. The force, measured by the scales, is 128 lb, so the work done in one minute is $166 \times 128 = 148{,}248$ ft-lb. Call this 149,200 for simplicity.

To turn this into horsepower is easy. One horsepower is defined as the production of work at the rate of 33,000 ft-lb per minute. So all we have to do is divide the actual ft-lbs delivered per minute by 33,000, giving us $149{,}200 \div 33{,}000 = 4.52$ hp. This, obviously, is a very small engine, suited to the simple type of brake employed.

We worked through the foregoing example step by step for clearness. In practice it will save time to use a formula. This formula can be developed exactly as this problem was solved:

Bhp = effective radius in feet $\times 2 \times 3.1416 \times$ number of revolutions per minute $\times$ the force, all divided by 33,000.

If "r" is the effective radius in *inches*, N the number of revolutions per minute and F the force, this comes down to

$$Bhp = \frac{r}{12} \times 2 \times 3.1416 \times N \times F \div 33{,}000 = r \times N \times F \div 63{,}025,$$ or $Bhp = r \times N \times F \div 63{,}000$ for all practical purposes.

Remember that in *this* formula you must use the effective radius *in inches*. For a check, let's apply the formula to the problem already worked out. Then Bhp $= 13.5 \times 165 \times 128 \div 63{,}000 =$ 4.52 hp (Check).

Fig. 2 shows another common form of prony brake. The arm should stand exactly horizontal, so it will bear straight down on the scales. In this case the effective radius or lever arm is the horizontal distance from the center of the wheel to the vertical line of the force. Method of figuring horsepower is same as for the rope brake.

Since I may have seemed to take some liberties in approximating the multiplication and division in the first problem, a few words of explanation are in order. A common mistake of practical men who start applying mathematics to their work is figuring too closely. Yet, no matter how many places of figures they have in their answer, they can't overcome the unavoidable errors in measuring wheel diameter, rope diameter, revolutions per minute, and force on scales.

You will note that I have approximated the multiplications and divisions to the third or fourth significant figure, which is working as fine as is worth while with equipment of this sort.

ARGUMENT CORNER

Final Word on Emptying Oil Drums

THE ARTICLES published in POWER on emptying oil drums by compressed air have been of much interest to me. Practices such as this naturally bring out the different viewpoints of readers.

I agree most emphatically with George Edwards' precautionary warning on this matter as stated in his article in your March issue.

Mr E J Duff in his article in your May issue wonders why Mr Edwards did not use his allotted space to show how oil drums could be emptied safely with compressed air. He goes on to state that if we followed Mr Edwards' principles we would not store compressed air in receivers because they occasionally fail.

It does not appear feasible to compare oil drums with air receivers in this manner, as they are not constructed to serve the same purpose. As we are all aware, a receiver constructed to hold any material under pressure must be designed and tested to withstand a pressure in excess of its working pressure.

Can we say that this is true in the case of oil drums? Their main use is to serve as a container for this material, held at atmospheric pressure without loss of contents during shipment.

Placing a hydrostatic test on one particular drum will not necessarily give you a safe working pressure to maintain on the next one you receive. Until you test the drum it cannot be stated definitely what pressure it will withstand and any value you set arbitrarily is unsafe.

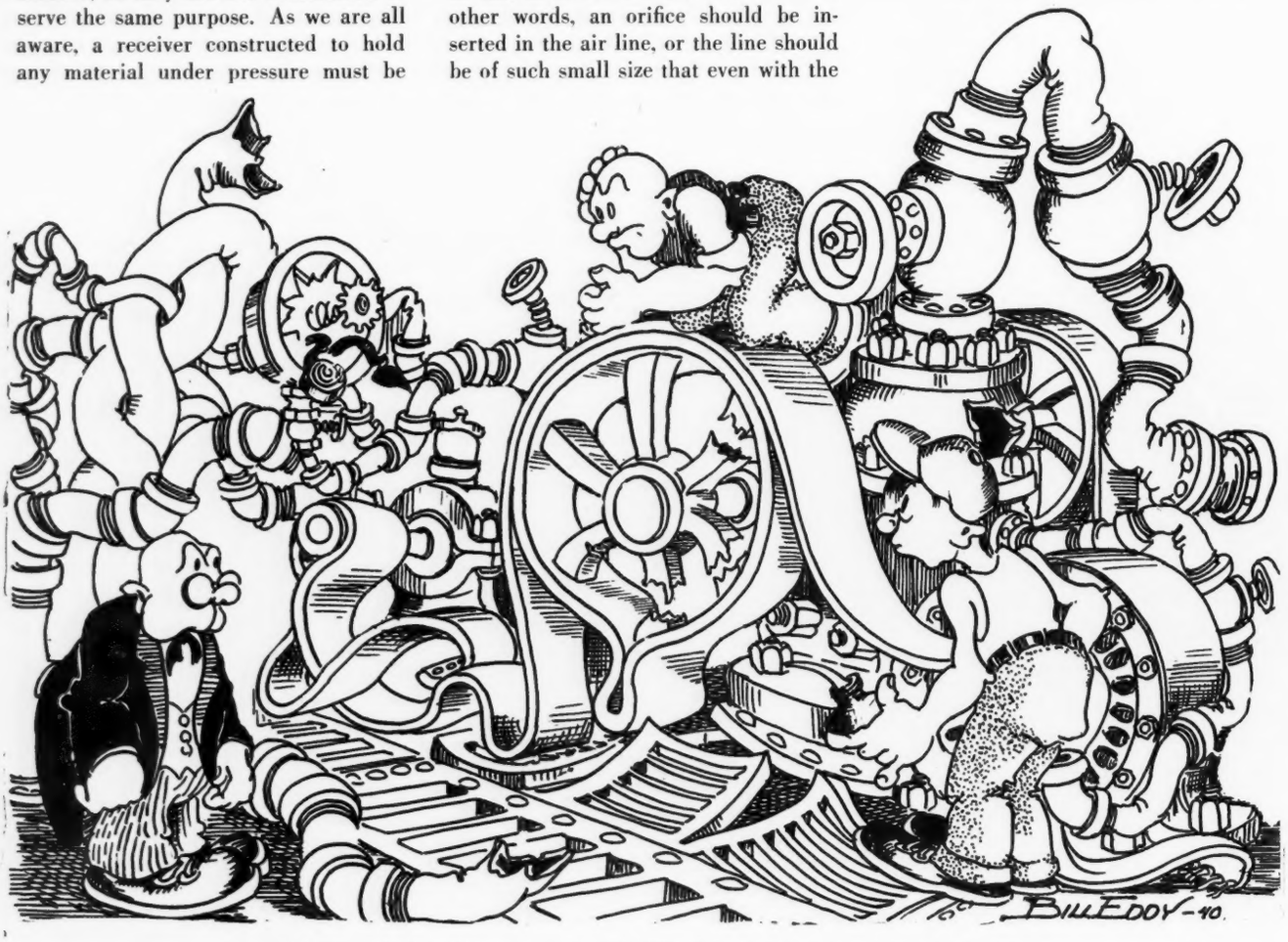
Mr Duff further goes on to state his method which he feels is perfectly safe. This method is much safer than the ordinary one of connecting the air line directly to the drum without a safety valve. He might have gone a step farther and stated that the safety valve should have sufficient capacity to relieve the air as fast as it could enter the drum. In other words, an orifice should be inserted in the air line, or the line should be of such small size that even with the valve wide open the safety valve would hold the pressure at the safe limit. It would also help to install a pressure gage so that action of the safety valve could be checked.

Owing to the unknown qualities of the oil drum, and any other drum for that matter, Mr Edwards is still correct in warning against the practice; as even with Mr Duff's safety measures the time might arrive when it would have been better to empty the drum by gravity.

Another point to consider is the fact that a large number of beginners read and use the practices as given in the various trade journals, and when men of Mr Edwards' caliber call attention to the ones which appear unsafe, it might be well if we stop and investigate.

Advice and suggestions, from those who have covered the roughest part and have learned by experience, even though it has been only embarrassing instead of bitter, should be received and accepted at their full value. Otherwise, how are we to broaden our mental scope and escape the pitfalls which we are bound to encounter if we take the stand that our own personal methods cannot be improved upon.

Conestoga, Pa. E W FELLER
Safe Harbor Water Power Corp

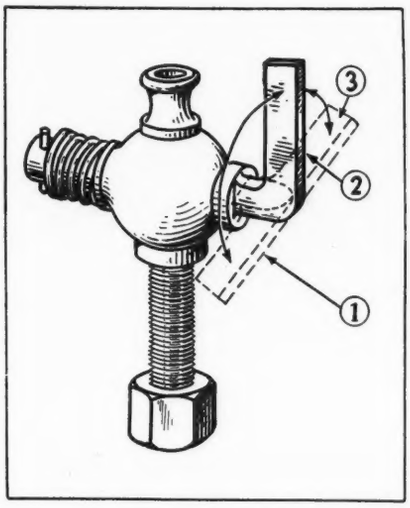


"Never mind writing me a report, Higgins, just issue a communiqué"

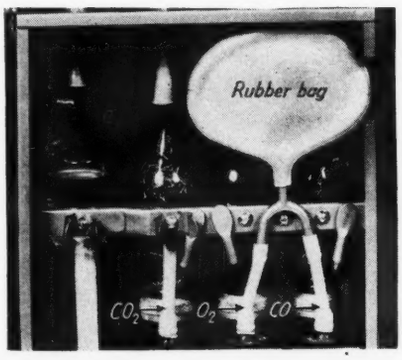
HOW TO RUN AN ORSAT

This is no place for a dissertation on the uses of a flue-gas analysis, except to remind the reader that high carbon dioxide (CO_2) means low excess air (hence low direct heat loss up the stack); that carbon monoxide (CO) reveals incomplete combustion, another loss; that the oxygen (O_2) measurement is often used chiefly as a check on accuracy of the analysis.

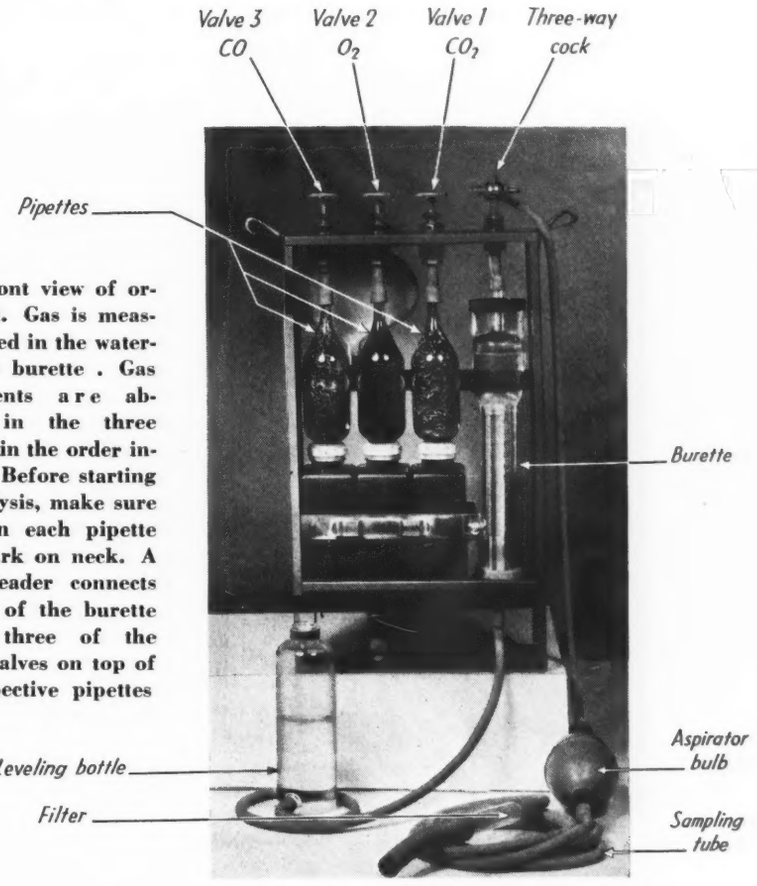
The orsat has been used for years to determine, from a sample of flue gas, the percentages by volume of CO_2, O_2 and CO. The equipment was loaned by the Hays Corp, the operations posed and photographed by POWER.



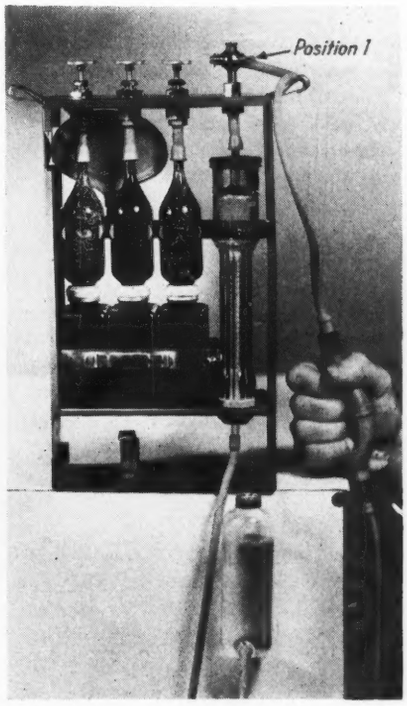
1A The 3-way cock in position 1 connects header and burette to gas-sampling tube; in position 2 it connects header and burette to atmosphere; in position 3 it shuts them off from air and gas



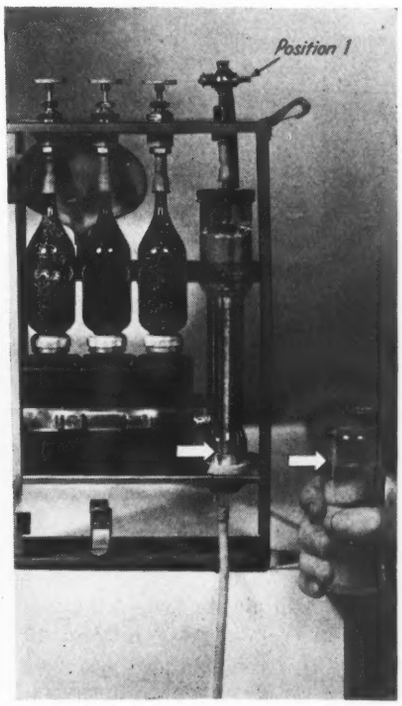
2 Remove rubber breather tubes on pipette chambers from solid plugs. That for CO_2 is left open to air, but connect the other two to the rubber bag, after bringing chemical to marks on necks of pipettes, because air exposure uses up chemicals



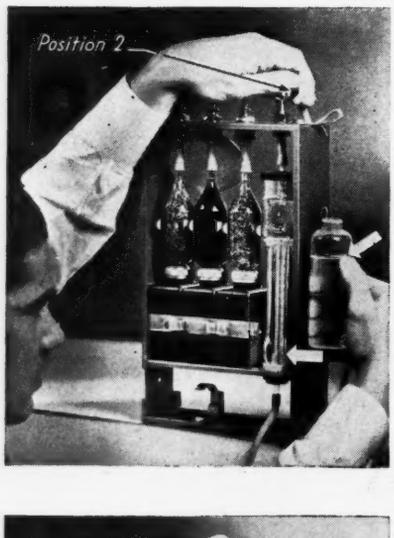
1 Front view of orsat. Gas is measured in the water-jacketed burette . Gas constituents are absorbed in the three pipettes in the order indicated. Before starting the analysis, make sure liquid in each pipette is at mark on neck. A small header connects the top of the burette to all three of the needle valves on top of the respective pipettes



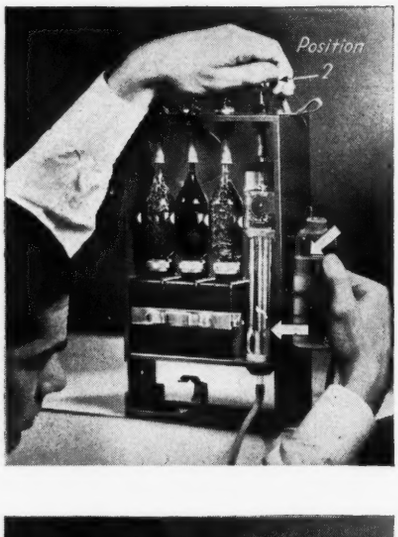
3 With leveling bottle hung from bottom of case and nearly full of tap water, and the cock at position 1, pump bulb to force gas into burette and through bottle



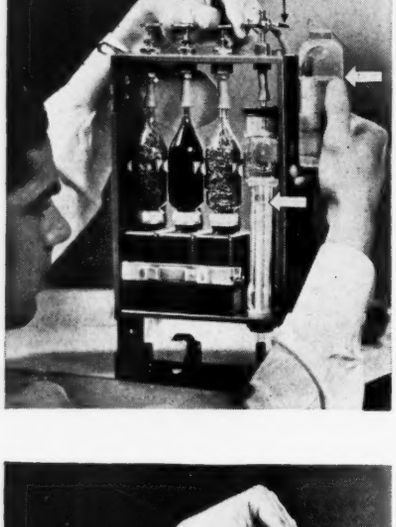
4 Raise bottle slowly until water shows well below zero mark near bottom of burette. Then hold bottle steady until both water levels are equal. Arrows show liquid levels



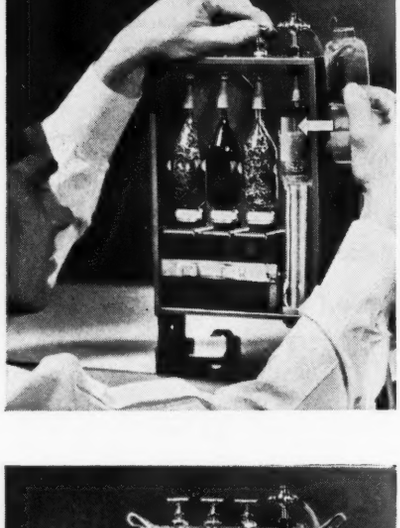
5 Clamp rubber connection at bottle tight with heel of right thumb. Raise bottle about 6 in. Swing cock to position 2. Release tube pressure *slightly* to allow gradual rise of water in burette



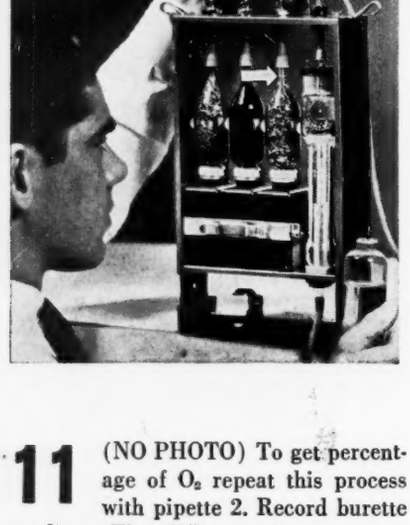
6 When level reaches zero exactly, clamp tube tightly and throw cock to position 3. Note: When measuring gas go by the bottom of liquid meniscus (curved surface) and have eye level with it



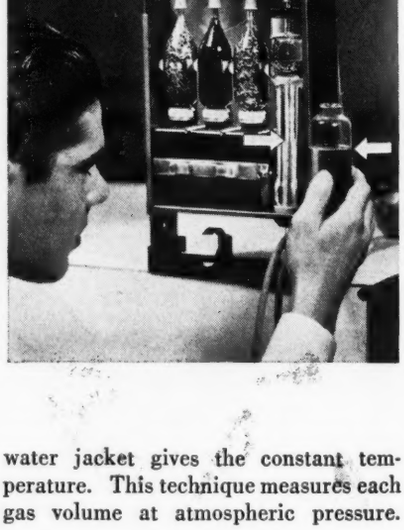
7 Raise bottle to position shown. Open CO_2 pipette needle valve 3 or 4 turns. Water will rise in burette, pushing gas over into pipette. Keep eye on rising water in burette and have heel of thumb ready to clamp off water flow



8 Clamp tube to slow down rising water as it approaches neck of burette. Stop it exactly at scratch on neck. Then, with tube clamped tight, close valve 1. Place bottle on table or hang on bottom of case for a few seconds to let CO_2 absorb



9 Hold bottle where indicated, open needle valve and keep eye on fluid rising in pipette. As it nears neck slow down with pressure on rubber tube and stop it exactly at mark on neck. Then close valve 1



10 Hold bottle so that liquid level in bottle is same as that in burette, so that gas will be measured at atmospheric pressure. With eye on same level, read burette at bottom of meniscis. Record reading as percentage of CO_2

11 (NO PHOTO) To get percentage of O_2 repeat this process with pipette 2. Record burette reading. The difference between second and first reading is the percentage of O_2. Then do the same for pipette 3 and the difference between third and second reading is percentage of CO.

NOTE 1—After the first absorption and measurement of CO_2, repeat to see if you get the same reading. If amount increases on second pass, take a third pass to make sure absorption is complete. It is essential that each constituent of the flue gas be completely absorbed before starting absorption of the next in series.

NOTE 2—To be comparable, all gas volumes must be measured at the same temperature and pressure. The burette water jacket gives the constant temperature. This technique measures each gas volume at atmospheric pressure.

NOTE 3—To save space it has been necessary to omit the procedure for setting up the equipment and charging the solution chambers. This is described in detail in the equipment instructions, or an experienced friend can help.

Tops!

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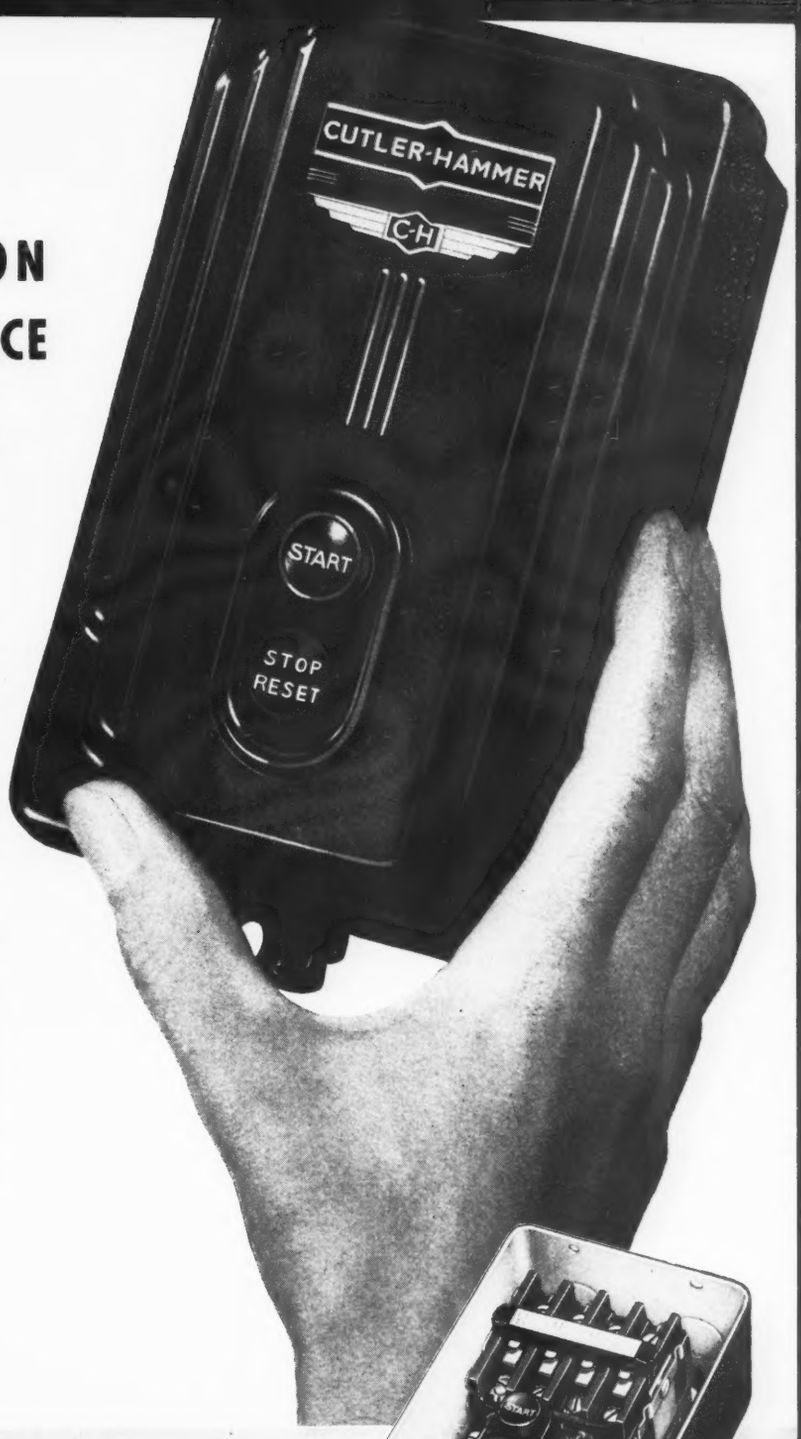
1ST in PERFORMANCE



e New C-H Size "O" Motor Control With Dust-Safe VERTICAL Contacts For Motors up to 2 H. P.

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Standard Features of C-H Bulletin 9586, Size "0" Pushbutton Magnetic Motor Control

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5. Mechanism mounted on common base plate, supported on soft rubber bushings. Removed by loosening one screw.
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7. Open type controllers available for built-in applications.
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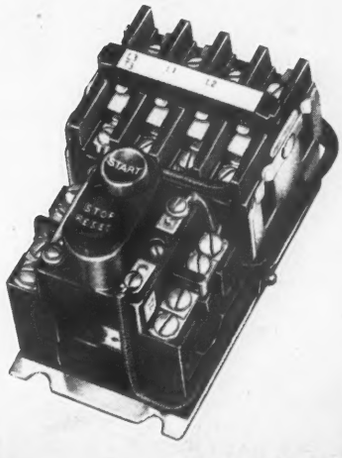
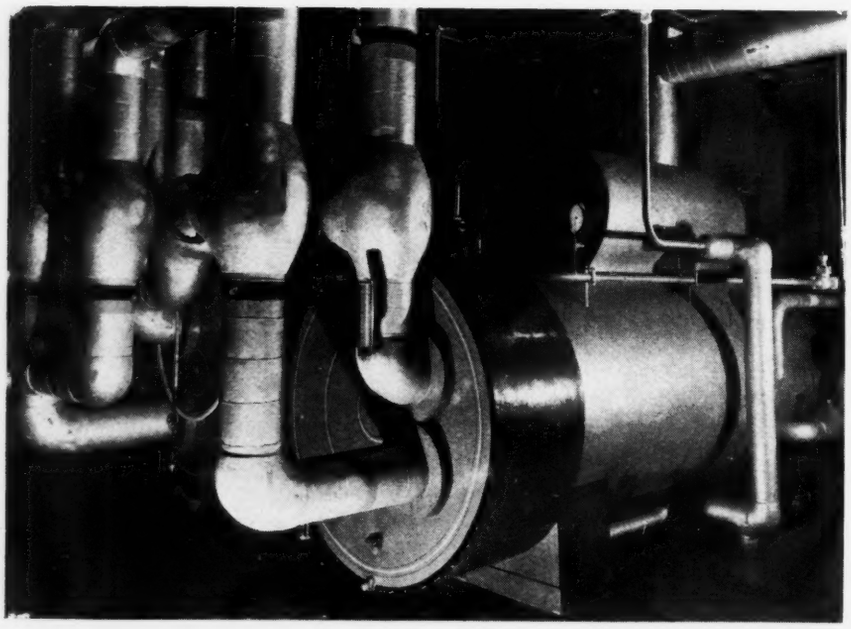
Dust between contacts causes heating and burning. *But dust can't settle on Vertical Contacts!* C-H Contacts are *always* vertical, hence *out* in the open, *air-cooled,* fully accessible.



Do You Run Your Refrigerating Plant by "Ear"?



If you do, installing a few thermometers will make a surprising improvement. A G Solomon tells where they will do the most good and what the readings mean in terms of everyday operation

▶ REFRIGERATION ENGINEERS usually lean heavily on pressure gages as guides to operation, particularly on the two "indispensables"—the discharge-pressure gage and the suction-pressure gage. But proper use of reliable thermometers helps so much in attaining and maintaining efficient operation that it seems safe to say that an operator who installed them at all points in his plant would soon find himself running the plant by "temperature." Let's see how thermometers fit into the picture and how, in conjunction with pressure gages, they pave the way to economical operation.

The discharge-pressure gage shows pressure carried on the condenser, liquid receiver, and piping from compressor to condenser to receiver to expansion valves. With good reason, operators consider this gage important; it warns when pressure reaches a dangerous point, because of lack of cooling water, water that is too warm, or excessive amounts of non-condensible gases in the system. It also shows when condensing surfaces are scaled or dirty.

By referring to the tables of refrigerant properties, we can readily determine what the high-side pressure should be. Since pressure and temperature of the saturated refrigerant are tied together, the high-side pressure will depend on the temperature of the cooling water. With clean condenser surfaces, ample cooling water, even distribution, and freedom from non-condensible gases, it is possible to maintain a condenser pressure equal to the saturation pressure for a temperature 5 F higher than the condensing water. Of course, in actual operation, condenser pressure will always run higher than this theoretical figure, but it gives the engineer a point at which to shoot. The lower the condenser pressure the lower the cost of operation.

An Aid to Efficiency

The discharge-pressure gage does not in any way indicate the temperature of the liquid refrigerant leaving the condenser, as pressure and temperature are not tied together for liquids as they are for saturated vapors. The nearer the temperature of the liquid leaving the condenser comes to the temperature of the saturated vapor in the evaporator, the better will be the over-all efficiency. The engineer looking for efficiency will want to know the temperature of the refrigerant leaving the condenser and will put a thermometer (1), see drawing on next page, where it can be watched closely and an accurate record kept in the daily log sheet.

Here are some of the questions this thermometer will answer for the inquiring engineer: Does the condenser need cleaning? Is the circulating pump doing full duty? Is the cooling tower or spray pond handling its job? Is water distribution even over condensing surfaces? Knowing the answers will help the engineer keep liquid temperature close to the lowest possible point.

Shows Insulation Need

Checking temperatures along the liquid line from the condenser will tell where insulation is needed. Thus the receiver should be cork or hair-felt covered if in a hot engine room as is so often the case. If on the outside of the plant, it should be protected from sun heat. The receiver should never be housed in a small shed or closet-like place without ventilation. If any part of the liquid line passes through a place where room temperature runs higher than that of the liquid, the line should be covered. There should be as little temperature rise as possible between condenser outlet and expansion valve. To check this doesn't mean a permanent thermometer in the liquid line

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YARWAY IMPULSE STEAM TRAP

ahead of each expansion valve, but there should be a well (2) so that correct temperature readings can be taken when desired.

In most large cold-storage and air-conditioning plants, some of the evaporators stand at considerable distances from the condenser and receiver. This means long liquid and suction lines. In many cases, these can be run together under a single covering, giving a low liquid temperature with no noticeable superheating of the vapor coming from the evaporator. Any excess liquid carried into the suction line will be evaporated by the heat that flows from the liquid in the liquid line.

After passing through the expansion valve, the refrigerant becomes the absorber and carrier of heat units. To make possible the transfer of heat, a temperature difference between refrigerant and substance being cooled must exist. Exactly how much temperature difference depends on several factors, the most important being the amount of surface in the evaporator. The greater the area, the less temperature difference required. Insulating effect of ice and frost formed on direct-expansion coils and speed of movement of the substance surrounding the evaporator also have a direct bearing on the temperature difference. In most refrigerating plants it will be found that best results obtain when the difference amounts to about 10 F. Thermometers (3) in the space or substance to be cooled give one part of this temperature difference as well as a direct indication of the effectiveness of the refrigerating process.

Most operators do not consider it good practice to carry the saturated vapor all the way through the evaporator and into the suction line if the evaporator is located close to the compressor. Some superheating must be allowed, but since the superheated vapor is practically useless in heat removal, the amount of superheat must be kept down. Close observation of results serves as the best guide in deciding what amount of superheating to allow, but to be any good observation must be based on measurement.

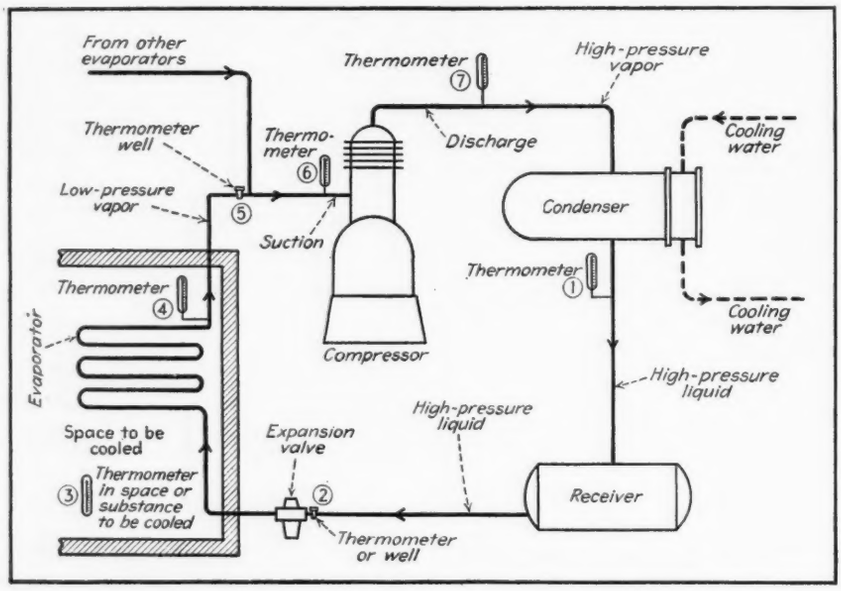
Best Suction Pressure

In a small plant with one compressor and one evaporator, the engineer can become readily familiar with the best suction pressure to carry and the distance that the frost line extends along the suction line to the compressor. In other cases, engineers scrape the frost from the evaporator outlet line and apply the "stick finger" test. If the finger sticks to the pipe, saturated refrigerant is passing through and if it doesn't the refrigerant is leaving the evaporator in the superheated state. This gives a crude guide to the proper setting of the expansion valve but neither this method nor the preceding one is better than just that—crude. The only answer is a thermometer (4) at the outlet of the evaporator and a daily log record of temperature readings.

If there are a great many coils or other evaporators, thermometer wells (5) should be placed at all important points where branch suction lines connect into the main suction header. This provides an easy way to trace the true state of the refrigerant at various points without a great outlay for instruments.

A thermometer (6) in the main suction line, close to the compressor, gives the engineer information that helps in operating the compressor at highest efficiency. If superheated gas passes into the compressor, it will be heated further by the hot valves, piston, and cylinder walls. This means less weight per cubic foot of gas and so reduces the actual amount of gas sent to the condenser. This, in turn, means less refrigerating effect for a given amount of compressor input.

From the standpoint of the state of the suction vapor, engineers find a great difference between horizontal double-acting compressors and vertical single-acting units. The former is often referred to as a "wet" compressor because it operates efficiently when the suction vapor passes through the valves carrying some unevaporated liquid. This entrained liquid evaporates as it takes up heat from the cylinder surfaces and in this way helps to lower the heat of compression. Many compressors of this type are fitted with expansion valves that allow introduction of liquid refrigerant directly into the suction line close to the compressor. Operators must handle these valves with care, as too much liquid reduces the amount of vapor taken from the evaporator.



Typical ammonia refrigeration cycle, showing suggested thermometer locations

Check Leaky Valves

Do not use the temperature shown by the suction-line thermometer when estimating the actual capacity of the compressor. The weight of the refrigerant sent to the condenser depends on the density and the higher the temperature, the lower the density. Since the vapor is always at a higher temperature after entering the cylinder (60–65 F under ordinary operating conditions) than in the suction, any figures based on the latter would be misleading.

The suction thermometer serves a highly useful purpose in telling the engineer when the compressor suction valves become defective and leaky. Any gas leaking through the suction valves will be highly superheated and this will show plainly on a thermometer located close to the compressor.

A thermometer (7) in the discharge line from the compressor shows the temperature of the refrigerant leaving the cylinder on its way to the condenser. The operating engineer has little, if any, control over this temperature. About all he can do is see that the refrigerant entering the compressor is at the proper temperature and state of saturation or superheat and that the cylinder cooling water does its job of removing heat of compression.

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Speed As You Like It With V-Belts

▶ INTO THE LIFE of almost every industrial machine comes the need, at one time or another, for a change—in speed. How this need is satisfied depends on several factors, such as kind of power available, speed range required, type of load, number of machines, etc. Where solely alternating current is used, a simple squirrel-cage motor in combination with some form of variable-speed transmission meets a wide range of adjustable-speed applications.

V-Belt Types

Of the many designs of modern variable-speed transmission, those using some form of V-belt form the largest group. Fig. 2 shows one of the simplest types, consisting of a Reeves Pulley Co combination flat-and-V-belt running on a flat-driven pulley and an adjustable-V-sheave on the motor shaft. The outer conical disk of the V-pulley can move inward or outward against tension of spring *S*. Speed is changed by shifting the motor on its base and adjusting spring *S* to vary pitch diameter of the sheave. This unit is made in small sizes only and speed variation is limited by the single sheave.

The U. S. Electrical Motors design (Fig. 1), giving wider speed range, has two pairs of conical-faced disks connected by a V-belt. Disk *D* is fixed, D_1 and D_2 can move along their shafts to adjust output speed, and disk D_3 is held, by calibrated spring *S*, in contact with the belt to maintain proper tension. Disks D_1 and D_2 connect through a mechanism to a screw and handwheel *W* so that they move in the same direction along their shafts when the handwheel is turned. In this way, the pitch diameter on one pair of disks increases as that of the other pair decreases.

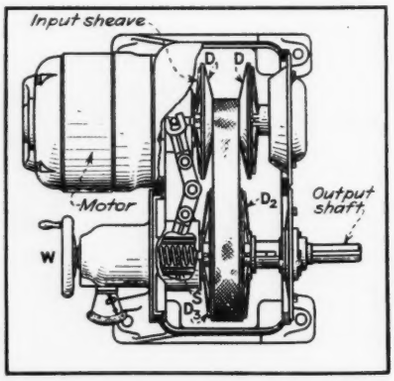


Fig. 1—Conical-faced disks D_1 and D_2 are the only adjustable disks in this unit.

In Fig. 1, disks are adjusted to the smallest input-sheave diameter and the largest output-sheave diameter, the setting for slowest output speed. Reversing this arrangement of sheave diameters gives maximum output speed. In between is an infinite number of speeds obtained by turning handwheel *W*. The driving motor is built as part of the unit and is directly connected to the input shaft. Unit capacities range from 0.25 to 15 hp; speed ratios go up to 6 to 1.

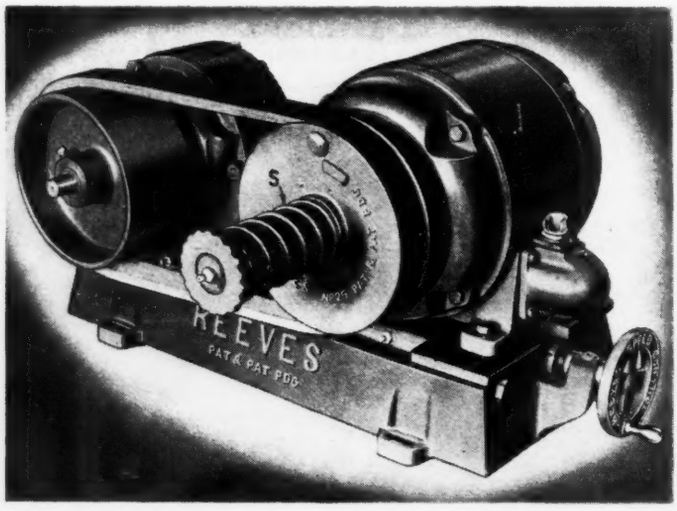
In another Reeves design, Fig. 3, speed control is also obtained by a V-belt running between two pairs of conical-shaped disks. Here, however, all four disks are double-spline-keyed to their shafts and are free to move. The disks connect to two levers in such a way that when disks *A* move together, disks *B* separate, or vice versa, thus changing the effective diameter on which the V-belt runs and thereby adjusting the speed.

The heavy, cable-cord, rubber belt is clamped between hardwood blocks, beveled and ground at their ends to fit the V-groove between each pair of disks (see Fig. 3). The beveled ends of both rows of blocks are tipped with a special tannage leather to give high coefficient of friction between belt and disks and load is evenly distributed between both rows of blocks. The belts are endless or are made with metal splicing block for easy replacement.

This transmission is built for speed ranges up to 16 to 1 and from fractional- to 75-hp sizes at maximum output speed, either horizontal or vertical, enclosed or open, and with or without the driving motor built-in.

Fig. 4 shows a Link-Belt Co variable-speed unit, operating on the same principle as the transmission, Fig. 3, but which uses a special V-chain to transmit power from one pair of case-hardened-steel conical disks to the other. Position of all four disks can be changed under load to adjust the ef-

(Continued on page 118)



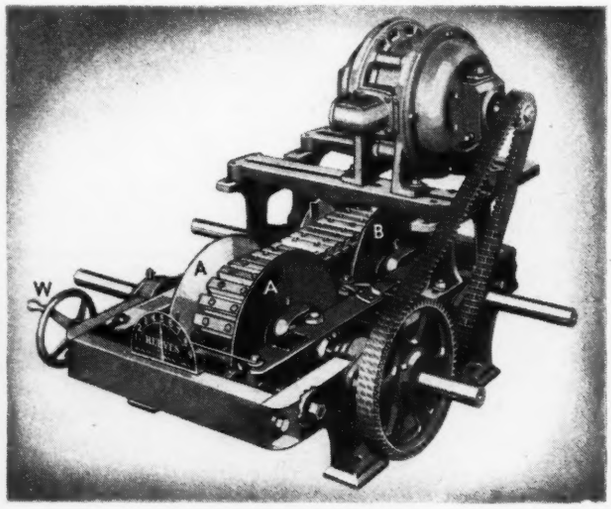


Fig. 2 (left)—Adjustable-diameter motor sheave belted to flat-driven pulley gives speed variation. Fig. 3 (right)—Pitch diameters of sheaves *A* and *B* are adjustable to give wide range of speed from the output shaft

The NALCO SYSTEM

will cover the water treatment problems in your plant

like a Blanket!

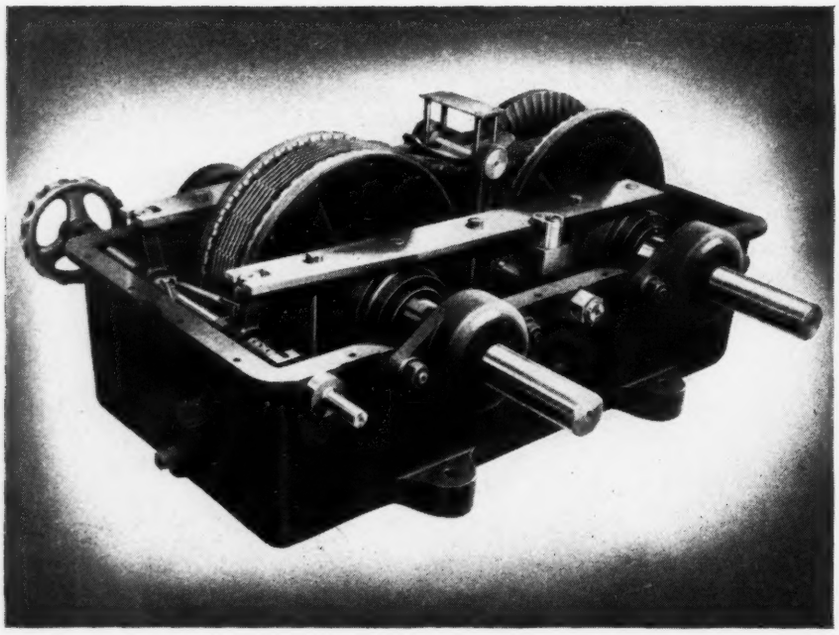
HERE'S what a lot of plant operating men like about Nalco: A COMPLETE WATER TREATING SERVICE! Not just boilers, but all equipment that comes in contact with water can be put under Nalco control. This means preventing scale and corrosion in heaters, pumps and economizers; stopping the plugging up of condensers and water lines; clarifying water for process uses; killing algae in cooling towers and spray ponds, etc. Let us show you how the Nalco System can blanket your entire plant. NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Ill.

The *Nalco* System of Feedwater Treatment

Inquiries other than domestic *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC, LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Speed As You Like It With V-Belts

(Continued from page 116)



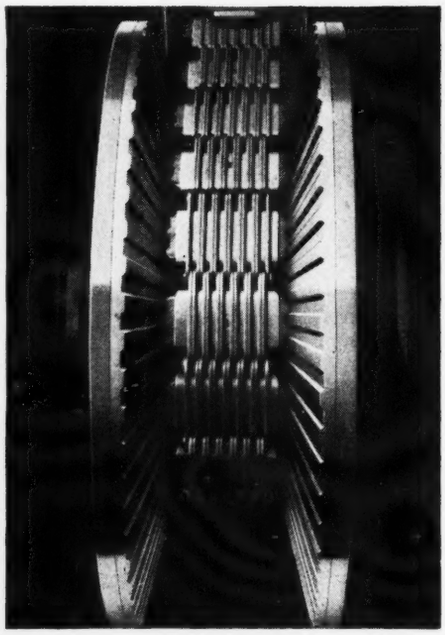


Fig. 4 (left)—A special type of chain runs between conical-faced steel disks in this transmission. Fig. 5 (right)—Laminations extending through the links in the chain and at right angles to them, fit into the disk teeth, giving a positive drive

fective diameter of each pair and change the output speed. Radial teeth, cut into the faces of the conical disks, engage adjustable teeth projecting beyond the sides of the chain to give a positive drive, Fig. 5.

The chain consists of a series of overlapping steel leaves or links, with joints made with hardened steel pins. There are no teeth on the inside of the chain. Instead, what may be called teeth are formed by packs of hardened steel laminations which extend through the links, at right angles to them, about ⅛ in. on each side of the chain. These laminations, although held together in their containers, are free to move from side to side individually with relation to each other. In this way they adjust themselves to engage the radial teeth on the faces of the conical disks.

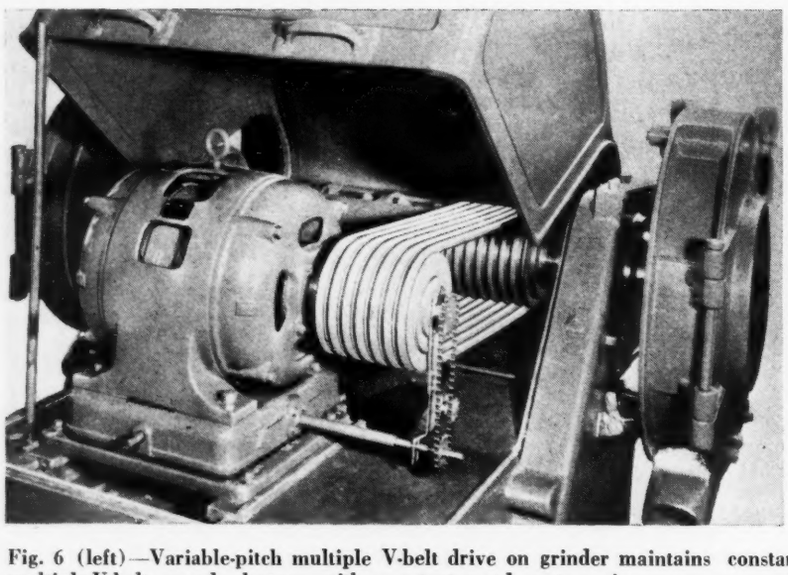
On each pair of conical disks the radial teeth are so staggered that the laminations can mesh correctly with them as the chain comes into contact with the wheels. Self-adjustment of the chain to any tooth width is thus assured. At each engagement of the chain and teeth of the conical disks, the laminations are regrouped within their separate containers, but they do not move while under working pull.

All elements of the unit are totally enclosed in an oil-tight housing, and are automatically splash-lubricated. Correct operating tension of the chain is maintained at all speeds by two hardened steel shoes that ride lightly on both chain strands, under constant spring pressure.

This transmission is manufactured in capacities up to 15 hp at maximum output speed and speed-change ratios up to 6 to 1, in both horizontal and vertical designs, with or without direct-connected gear motors.

Multiple-V-belt drives for adjustable-

(*Continued on page* 132)



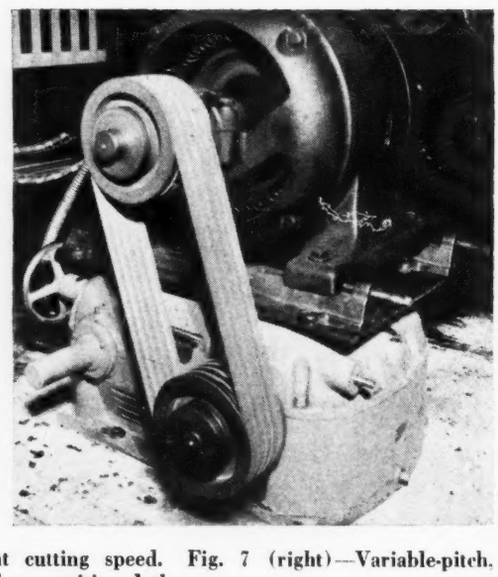


Fig. 6 (left)—Variable-pitch multiple V-belt drive on grinder maintains constant cutting speed. Fig. 7 (right)—Variable-pitch, multiple-V-belt speed changer with constant-speed motor gives correct speed on suiting-cloth presser

THREE QUESTIONS... THREE ANSWERS!

1 **Are You Using Motors that Give Your Machines Best All-Around Performance?**

2 **Are You Protecting Your Production Schedules (and Your Profits) from the Danger of Shutdowns Due to Motor Failures?**

3 **Are You Getting the Long Life and Low Upkeep Expense that Allis-Chalmers Lo-Maintenance Motors Offer You?**

AS A MOTOR USER, do you ask yourself these three vital questions when you select motors for your machines?

If you do, you'll be interested in the case histories shown here . . . three answers to these questions . . . three out of the thousands of users that have acclaimed Allis-Chalmers Lo-Maintenance Motors for their outstanding performance, low maintenance, and long life!

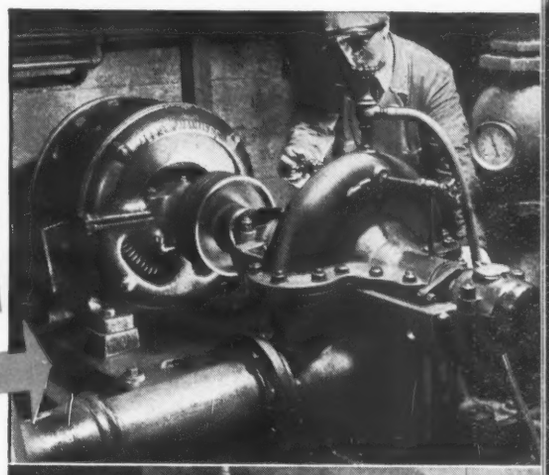
For, in each Lo-Maintenance Motor, you get more than a motor that delivers just a certain rated horsepower. High carbon steel frame . . . indestructible rotor . . . distortionless stator . . . no skimping on materials — these are extra-value features that give you full-measure performance.

To get complete details, see the trained power engineer in the district office near you . . . or write Allis-Chalmers, Milwaukee . . . today!

A 1257

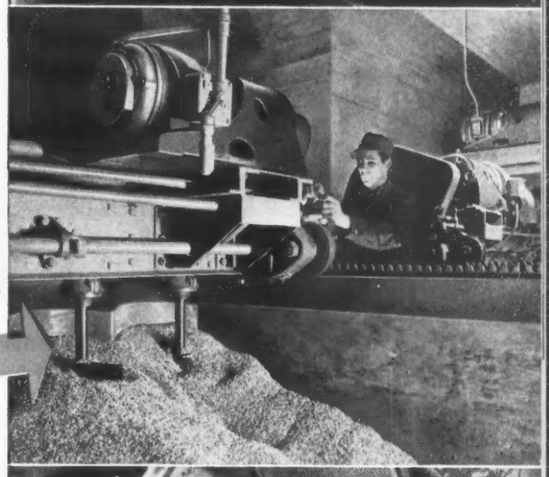
20 YEARS AT HARD LABOR!

Twenty years on the job . . . 24 hours a day . . . in a spot exposed to heat and moisture . . . with not one cent spent for repairs—that's the day-in and day-out history of this Lo-Maintenance Motor operating in a midwestern brewery.



NO TIME-OUTS FOR REPAIRS!

Operating continuously 24 hours a day . . . this Allis-Chalmers Lo-Maintenance Motor is typical of the 86 that have been seven hard years on the job in this industrial plant with no time-outs for repairs!



25 MOTORS . . . 36 YEARS EACH!

Fighting some of the worst operating conditions any motors could meet—that's what 25 Lo-Maintenance Motors, one of them pictured here, had to do for 36 years in a gas house . . . without running up costly repair bills!

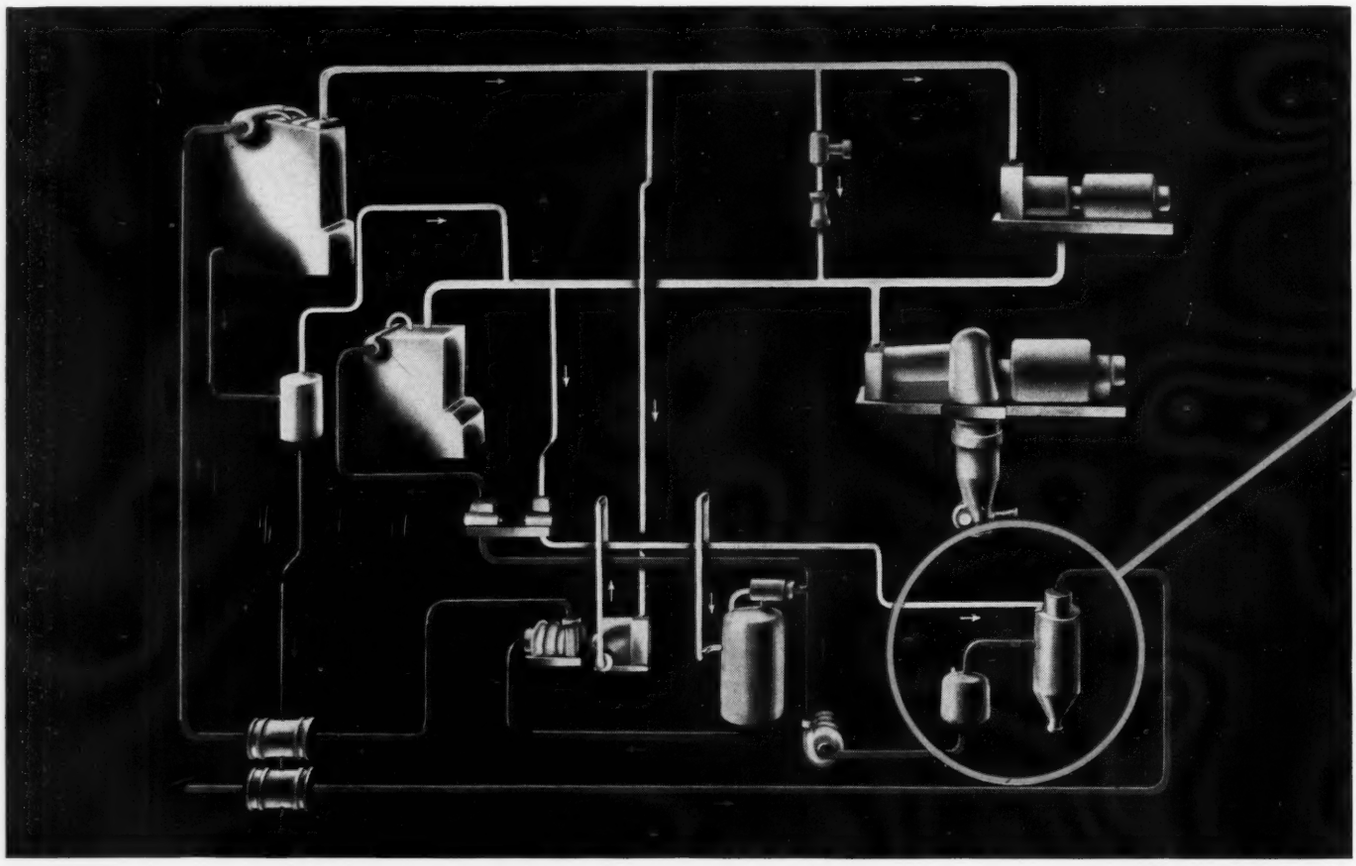
Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

FROM *GOOD* POWER HOOKUPS

FOR FEEDWATER TREATMENT No. 1...



Courtesy—Power Magazine

HOOKUP #20 **Modern steel mills use large quantities of power, little process steam, so plant hookups resemble central stations. Low-pressure turbines with barometric condensers supplied this mill; plant is now modernized by high-pressure boilers and topping turbines. High pressure and 100% makeup demand effective feed treatment; hot-process lime-soda with metaphosphate added at feed-pump suction suit this case. Steam washer in boiler drum completes arrangement.**

THE QUESTION of Feedwater Treatment is so important and varied that we have planned three basic Hookups—of which this is the first.

A simple variation of the first method shown at the right would employ simply a sedimentation tank, pressure filter and chemical mixer. Chemical solution, prepared in a small tank with motor-driven agitator, is added to the sedimentation chamber. A filter, using sand or other granular material removes organic matter and solids.

Many water supplies, however, are more suitably treated by the hot process shown, in which steam supply from engine exhaust, or other source, raises water temperature in the tank to desired point. Provision is made for backwashing to recover chemicals otherwise wasted.

The Iron Body—Bronze Mounted Valves listed for the solution lines will handle some of these chemicals—although All-Iron Valves are available where necessary.

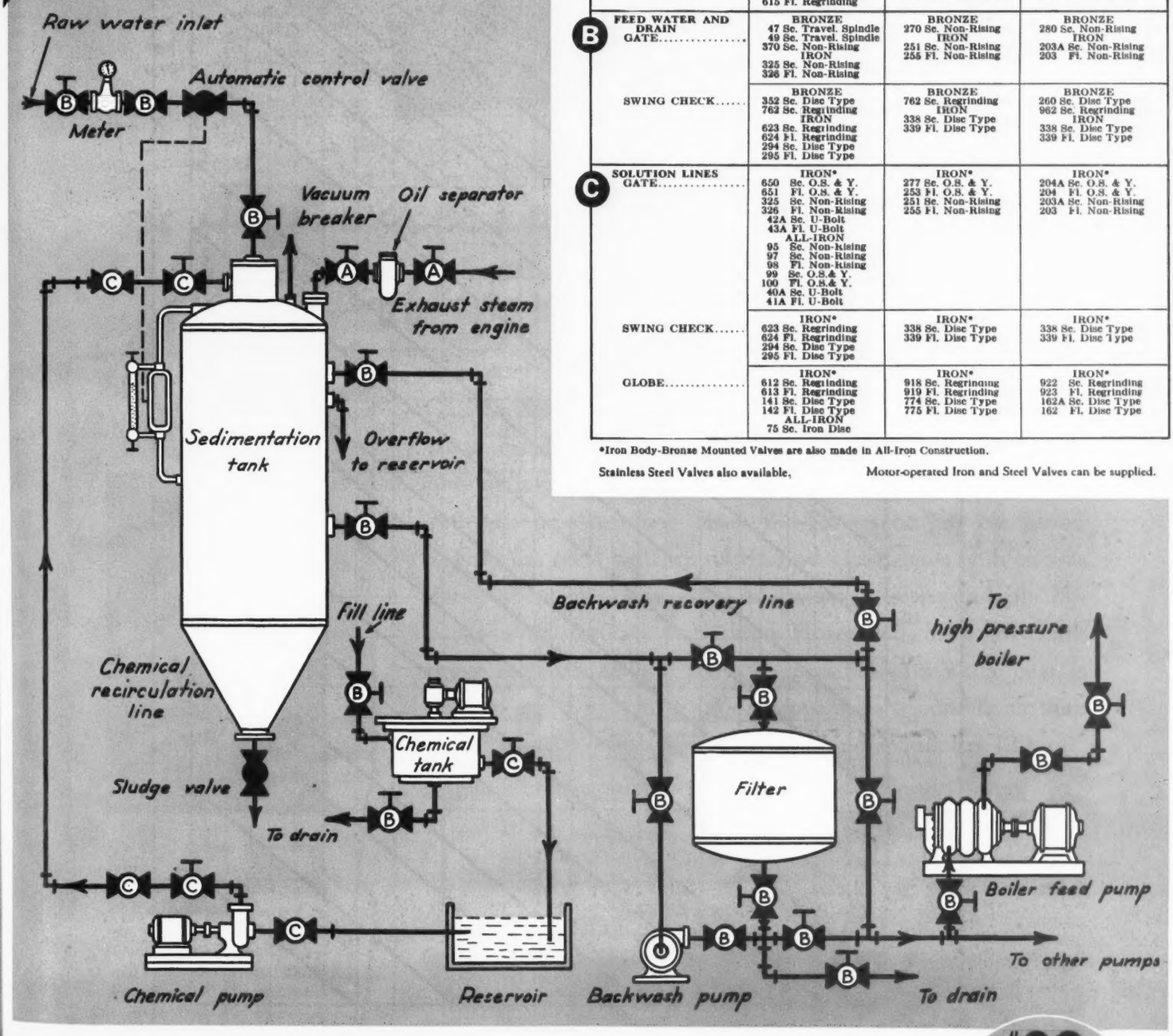
NEXT MONTH—
CHEMICAL ADDED AT BOILER FEED SUCTION

IN VALVES *Jenkins* GIVES YOU EVERYTHIN

. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

HOT PROCESS WATER TREATMENT



REFERENCE CHART TO JENKINS FIGURE NUMBERS FOR FEED WATER TREATMENT No. 1

		Standard	Medium	Extra Heavy
A	STEAM SUPPLY GATE	IRON 651 Fl. O.S. & Y.	IRON 253 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y.
	GLOBE	IRON 142 Fl. Disc Type 913 Fl. Regrinding 613 Fl. Regrinding	IRON 775 Fl. Disc Type 919 Fl. Regrinding	IRON 162 Fl. Disc Type 923 Fl. Regrinding
	ANGLE	IRON 144 Fl. Disc Type 915 Fl. Regrinding 615 Fl. Regrinding	IRON 777 Fl. Disc Type 921 Fl. Regrinding	IRON 163 Fl. Disc Type 925 Fl. Regrinding
B	FEED WATER AND DRAIN GATE	BRONZE 47 Sc. Travel. Spindle 49 Sc. Travel. Spindle 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising
	SWING CHECK	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type
C	SOLUTION LINES GATE	IRON* 650 Sc. O.S. & Y. 651 Fl. O.S. & Y. 325 Sc. Non-Rising 326 Fl. Non-Rising 42A Sc. U-Bolt 43A Fl. U-Bolt ALL-IRON 95 Sc. Non-Rising 97 Sc. Non-Rising 98 Fl. Non-Rising 99 Sc. O.S.& Y. 100 Fl. O.S.& Y. 40A Sc. U-Bolt 41A Fl. U-Bolt	IRON* 277 Sc. O.S. & Y. 253 Fl. O.S. & Y. 251 Sc. Non-Rising 255 Fl. Non-Rising	IRON* 204A Sc. O.S. & Y. 204 Fl. O.S. & Y. 203A Sc. Non-Rising 203 Fl. Non-Rising
	SWING CHECK	IRON* 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	IRON* 338 Sc. Disc Type 339 Fl. Disc Type	IRON* 338 Sc. Disc Type 339 Fl. Disc Type
	GLOBE	IRON* 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type ALL-IRON 75 Sc. Iron Disc	IRON* 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	IRON* 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type

*Iron Body-Bronze Mounted Valves are also made in All-Iron Construction.

Stainless Steel Valves also available, Motor-operated Iron and Steel Valves can be supplied.

JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.

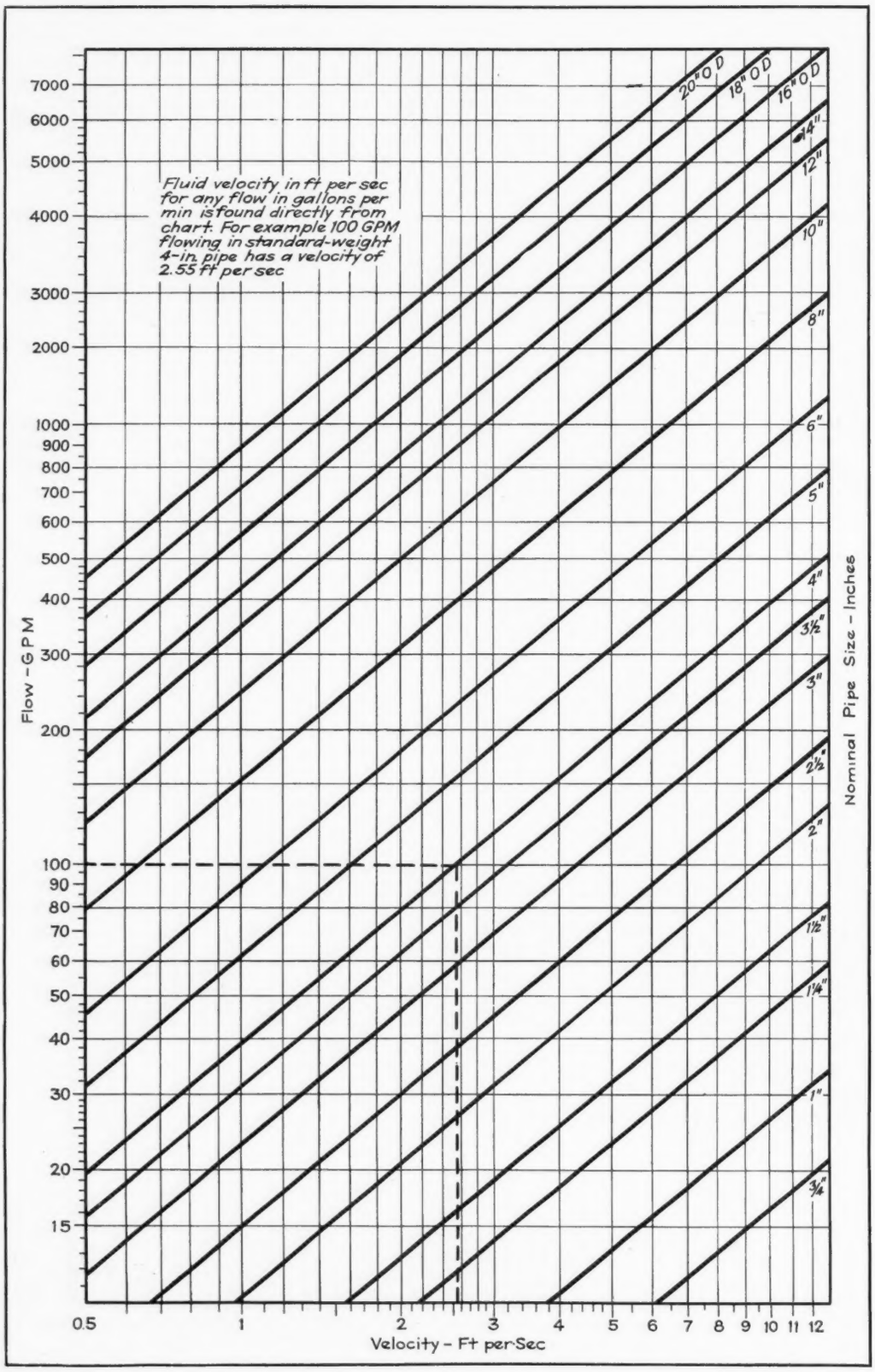
Bridgeport • Boston • Chicago Philadelphia • Atlanta • Houston

TRADE JENKINS MARK Jenkins Bros.

#20 OF A SERIES designed to help in your selection of JENKINS VALVES

Number 96

Flow Velocity for Standard-Weight Pipe

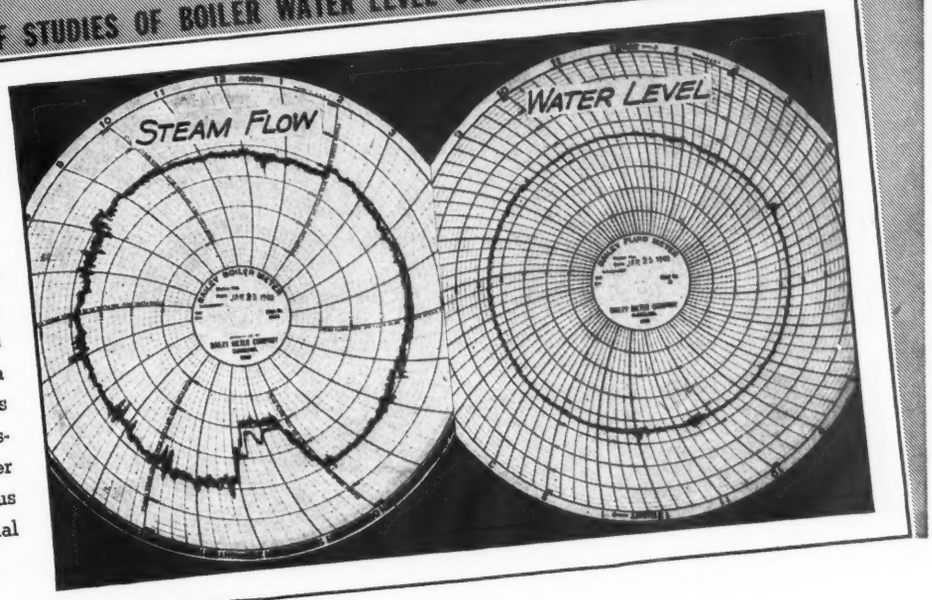


© POWER

NO. 6 IN A SERIES OF STUDIES OF BOILER WATER LEVEL CONTROL WITH COPES FLOWMATIC

1300 POUNDS W. S. P.

Fired with pulverized coal or oil, this 1300-lb. B. & W. boiler in prominent Eastern utility plant normally evaporates 275,000 lb. per hr. with a maximum 300,000 lb. Excess water pressure at pump discharge is 250-300 lb. Boiler water level held within plus or minus one inch of normal by the COPES Flowmatic.



★ High excess water pressures have little effect on the level control

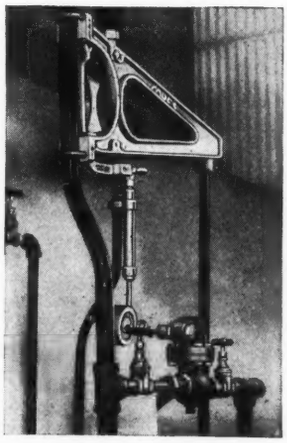
You need not worry about high excess water pressure if a COPES Flowmatic Regulator controls the boiler feed and water level. These charts show water level varying only plus or minus one inch with an excess pressure of 250 to 300 pounds. In other cases, the Flowmatic has continued to hold the level well within desired close limits with excess rising above 450 pounds. And service is dependable because even the relay-operated Flowmatic, used for high pressures, has as few parts as possible and each part is built to stand up under much more severe conditions than it will meet in operation. Write for new Bulletin 429.

NORTHERN EQUIPMENT CO., 701 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

FOR SMALL BOILERS



On small boilers at moderate ratings and pressures, the COPES Type OT quickly pays for itself with correct, continuous feed that means more steam per pound of fuel. Makes operation safer by stabilizing water level. Fully-automatic, it saves time for operators. Write for Leaflet P-2A.

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

(Continued from page 81)

F F Bahnson, consulting engineer for the Bahnson Co, Winston-Salem, rates as a gentlemen, engineer, business man and all-round mechanic

that I have no record of their size. Steam at 150 lb pressure runs 2080 ft from White Oak to a turbine at the Print Works through a 14-in. overhead main, and then another 2500 ft to Revolution through a 12-in main.

When I visited this plant a new Combustion Engineering steam-generating unit, No. 4, was nearing completion. Fired by pulverized coal, this unit will have an hourly capacity of 150,000 lb of steam at 450 lb and 710 F. Auxiliary equipment will include two big Richardson coal scales and Bailey control.

Winston-Salem

Leaving Proximity, we drove on to Winston-Salem. The land is higher and the climate more snappy. Winston-Salem lies in the heart of the great "Piedmont" tobacco-processing region. Here is one town where you don't have to walk a mile for a Camel. The Camel factory is just a few blocks from the Robert E Lee Hotel.

Before tackling the tobacco industry on a big scale, I paid a brief visit to Chester Shelton, master mechanic, and Carl E Smith, assistant engineer, P A Haynes Knitting Co. Plant contains two 5000-sq-ft Heine boilers, with Riley stokers and Elesco superheaters. This equipment was installed about 1929. Steam at 300 lb and 300 F superheat drives an 825-kw Allis-Chalmers turbine, exhausting at 30 lb.

Next stop was R J Reynolds Tobacco Co, a concern of astronomical dimensions, makers of Camel cigarettes and Prince Albert smoking tobacco. There I spent about an hour with Chief Engineer R P Reece, whom I had met five years before. Mr. Reece is a modest man, makes little noise, but his power responsibilities in this great factory are notable. Total floor space devoted to manufacturing is 66 acres, with another 138 acres of storage floors, a total of 204 acres. Nor does this include anything outside of Winston-Salem.

The total generating capacity of 11,250 kw and 380,000 lb steam per hour is now pretty well concentrated in one big generating plant. Two condensing turbines supply bled steam at 10 lb. The single non-condensing turbine bleeds at 150 lb and exhausts to process at 10 lb. Most of the boiler steam is produced at 385 lb and 640 F.

Here, as in many other large process plants of North Carolina, heat balance is very good; little steam goes to condenser. Mr Reece showed me his hourly load curves; the process-steam-demand curve was almost a twin brother of that for electricity.

Here's an interesting item! Four or five years ago Mr Reece installed an Allen-Sherman-Hoff ash-sluicing system. Sale of the washed cinders, for which there is a steady demand, paid for the system in four years, including all costs of operation and maintenance.

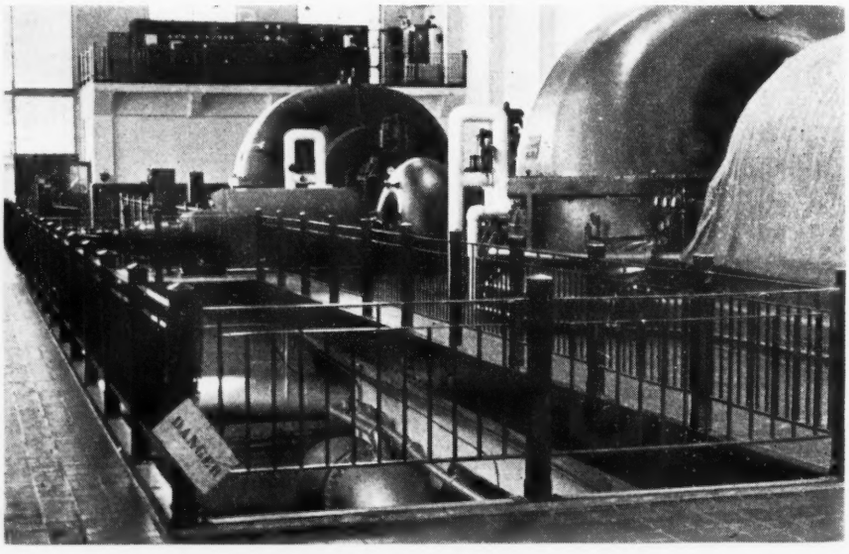
Before leaving this fine historic town of Winston-Salem I paused for a most interesting session in the plant of the Bahnson Co. C E McCallum, heating engineer, showed me around the factory, where they were making humidifiers and controls. These are sold mostly in the textile and tobacco plants of the Southeast, but some go to the far corners of the globe. I was impressed chiefly by the number of first-class mechanics—machinists, welders, sheet-metal workers, and so on. Here is a significant trend in the South. Its great textile, tobacco, paper and chemical operations are gradually breeding men who can build and repair the production machinery. Some day I expect North Carolina to be as full of good all-round mechanics as New England is today.

I had a particularly interesting session with Mr F F Bahnson, consulting engineer, a man whose forbears were in Winston-Salem before the Revolution. Mr Bahnson took me around the corner to another little factory of which he is president. Here he makes steel slides, fastenings and other metal fittings for sale to furniture manufacturers.

After a night in Salisbury, I stopped a few hours at Spencer to inspect the Buck Station of Duke Power Co. I was cordially greeted by plant superintendent W E MacDowell, and assistant superintendent R A Cox, who gave me a fine example of just how hospitable Southerners can be to a damyankee visitor. I hereby officially record my appreciation of such attention.

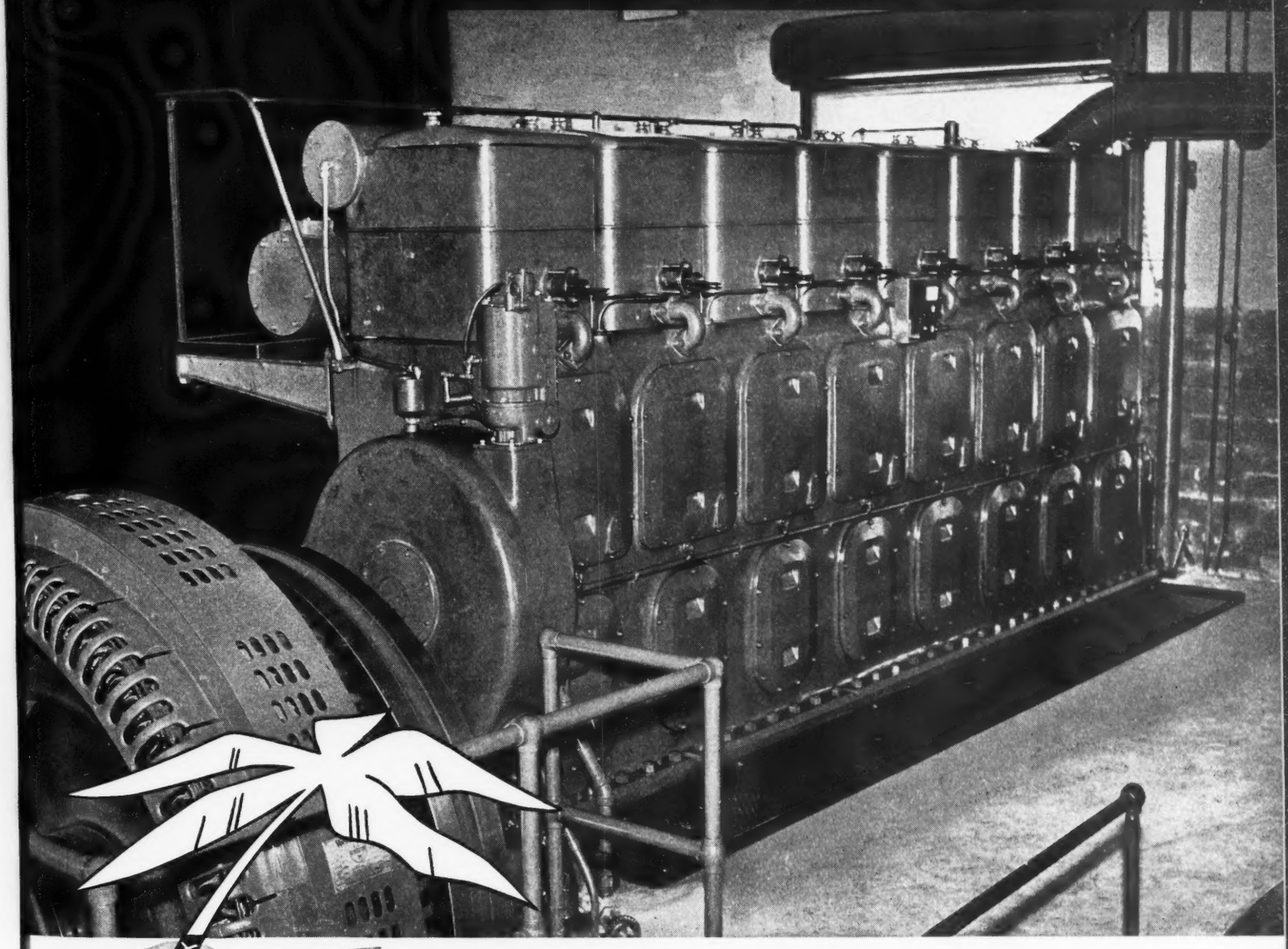
The present Buck plant has four boilers of 350,000 lb per hr capacity each —B & W units with water-wall tubes on three sides of the furnaces. They burn pulverized coal, using about 14 burners per boiler. Steam is generated at 400 lb and 700 F. Foundations were being laid for a new 80,000-kw unit to operate at 900 lb and 900 F.

Commenting on differences between North and South, Mr MacDowell expressed the opinion that the South has the better way of life. As he put it, "we don't rush around as much, but get just as much accomplished."



Turbine room of Buck Station, Duke Power Co

MORE H·P–LESS SPACE



3RD DE LA VERGNE DIESEL
FOR LAKE WORTH, FLORIDA

The 3rd De La Vergne Diesel installed in the City Light Plant at Lake Worth, Florida, is a Model VM rated at 1,000 bhp at 327 rpm. Compact yet conservatively rated, this engine occupies considerably less floor space and headroom than engines of similar rating. • Bulletin 138 descriptive of the Model VM De La Vergne engine will be forwarded upon request.

BALDWIN DE LA VERGNE SALES CORP.

THE BALDWIN GROUP

Subsidiary of THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

POWER LINES

Smoke Prevention Engineers Hear Story of St. Louis

The Smoke Prevention Association, consisting of smoke commissioners of many municipalities, railroad combustion engineers, coal operators and firing-equipment manufacturers, learned first-hand of St Louis' increased efforts at smoke elimination at the 34th annual convention May 21-24. In welcoming the convention, Mayor Bernard F Dickmann remarked that St Louis had spent over a hundred million dollars in the past 15 years beautifying the city and that engineers, medical men, real-estate interests and the general public were all actively supporting the present drive.

Ray Tucker, hard-hitting smoke commissioner and spearhead of St Louis' new laws, reported that he had received written assurance from upwards of a hundred local large fuel consumers that they would comply with both letter and spirit of the ordinances. Railroads, according to R C White, Missouri Pacific executive, have been tackling the smoke problem for many years on the basis that smoke represents poor and inefficient combustion. At present, he said, trouble with smoke has been practically eliminated on through runs; attention is being concentrated on yards and roundhouses.

At the technical session, R J Piersol of the Illinois State Geological Survey described laboratory apparatus for determining the potential smoking qualities of a coal by burning a small sample under controlled conditions and measuring the density of resulting smoke with a photoelectric cell. This investigation has shown, he said, that the low temperature portion of the volatile content is the smoke producing ingredient and that the percent volatile content may be a misleading index of smoke production. He added that dry coal has a noticeably lower smoke index than damp coal and that slightly weathered coal makes less smoke than freshly mined fuel.

A review of the legal aspects of smoke abatement was presented by Ralph G Johansen, Hays Institute of Combustion. Laws enacted to protect the health of the public have been declared valid, he stated, in many court decisions but that operators

(Continued on page 164)

TYPICAL GAS-ENGINE INSTALLATIONS

50 Additional Installations In or Under Construction Since April 1, 1939 Received Since Compilation of Table in June Power, Pages 71, 72

Owner	Location	Equipt. Driven	Engine builder	No. units	Hp	Speed, rpm	No. cyl	Cyl bore	Cyl stroke	Cycle	Btu per hphr	Type of fuel	Btu per cu ft fuel
Texas Public Service Co.	Beaumont, Texas	Pump	IR	1	650	300	8	14½	18	4	.....	Nat.	....
		Pump	IR	1	270	400	6	11	13½	4	.....	....	....
Hunt Oil Co.	Long Lake, Texas	Comp	IR	2	650	300	8	14½	18	4	.....	....	....
Coronado Corp.	Woodsboro, Texas	Comp	IR	2	650	300	8	14½	18	4	.....	....	....
Tidewater Associated Oil Co.	Cayuga, Texas	Comp	CB	2	600	300	6	14	14	2	.....	Nat	....
		Comp	CB	1	400	300	4	14	14	2	.....	Nat	....
Hidalgo-Cameron Water District	Mercedes, Texas	Pump	Wor	2	500	350	5	15	17½	4	.....	Nat	1000
Shell Oil Co.	Magnolia, Ark.	Comp	IR	5	485	300	6	14½	18	4	.....	....	....
Tidewater Associated Oil Co.	Long Lake, Texas	Comp	CB	4	400	300	4	14	14	2	.....	Nat	....
		Comp	CB	2	300	300	4	12	14	2	.....	Nat	....
Continental Oil Co.	Benevides, Texas	Comp	CB	2	400	300	4	14	14	2	.....	Nat	....
Liberty	Texas	Gen	CB	2	300	400	6	11½	13½	4	.....	Nat	1050
H M Harrell	Bammell, Texas	Comp	IR	5	300	350	8	11	12½	4	.....	....	....
Union Sulphur Co.	Sulphur, La.	Comp	IR	2	225	350	6	11	12½	4	.....	....	....
Mills-Bennett Products Co.	Bruni, Texas	Comp	IR	1	225	350	6	11	12½	4	.....	....	....
Humble Oil & Refining Co.	Wickett, Texas	Gen	CB	5	150	400	3	11½	13½	4	.....	Nat	....
Magnolia Petroleum Co.	Mirando City, Texas	Pump	CB	1*	140	300	2	12½	15	2	.....	Nat	....
J A & J M Smith	East Point, Ga.	Corn Mill	AC	1	90	750	6	5¼	6½	4	.....	Nat	980
C D Shaw Gin Co.	Cartersville, Ga.	Gin	AC	1	90	750	6	5¼	6½	4	12,000	Nat	980
Arkansas Fuel Oil Co.	Benevides, Texas	Comp	CB	1*	70	250	1	13½	16	2	.....	Nat	....
Irving Theater	Detroit, Mich.	Ref Comp	Cont	1	60	1200	6	4½	5¼	4	12,000	Nat	1014
The Texas Co.	Myrtis, La.	Pump	CB	6*	45	180	1	12½	16	2	.....	Nat	....
McBride Feed & Grain Co.	Newman, Ga.	Feed Mill	Int	1	40	1200	6	....	....	4	13,000	Nat	980
Crystal Theater	Detroit, Mich.	Ref Comp	Cont	1	40	1100	6	4½	4½	4	12,000	Nat	1014
Louis Fineman Co.	Detroit, Mich.	Ref Comp	Cont	1	40	1200	6	4½	4½	4	12,000	Nat	1014
Grand River Chevrolet	Detroit, Mich.	Gen	Chev†	1	40	1800	6	3½	3¾	4	13,000	Nat	1014
Lasky Theater	Detroit, Mich.	Ref Comp	Cont	1	40	1100	6	4½	4½	4	12,000	Nat	1014
Union Producing Co.	N. Louisiana	Oil Pump	CB	31	40	400	2	7½	9	2	.....	Nat	....
Epworth Manufacturing Co.	Detroit, Mich.	Gen	Ford†	1	30	1250	8	3 3/16	3¾	4	13,000	Nat	1014
Grand Motor Sales	Detroit, Mich.	Gen	Ford†	2	30	1800	8	3 1/16	3¾	4	15,000	Nat	1014
Hercules Forging Co.	Detroit, Mich.	Gen	Linc†	1	30	1225	8	3½	5	4	14,000	Nat	1014
Maryon Hosiery Mills	Carrollton, Ga.	Gen	Buick†	1	30	900	6	....	....	4	13,000	Nat	980
W A Gabel, Inc.	Detroit, Mich.	Ref Comp	Cont	1	25	1160	6	3¼	4⅜	4	12,000	Nat	1014
Burger Creamery	Detroit, Mich.	Ref Comp	Cont	1	25	1200	6	3¼	4⅜	4	12,000	Nat	1014
Peter Pan Bakery	Detroit, Mich.	Ref Comp	Cont	1	25	1100	6	3¼	4⅜	4	12,000	Nat	1014
White Rust Proof Co.	Detroit, Mich.	Gen	Chry†	1	25	1150	6	3⅜	4 1/16	4	14,000	Nat	1014
Hirt, Inc.	Detroit, Mich.	Ref Comp	Ford†	1	25	1150	8	3 3/16	3¾	4	12,000	Nat	1014
P A Breitenbeck Co.	Detroit, Mich.	Ref Comp	Cont	1	25	1160	6	3¼	4⅜	4	12,000	Nat	1014
Michigan Lead Co.	Detroit, Mich.	Gen	Hall†	1	25	1100	4	4¼	5½	4	12,000	Nat	1014
Navarro Oil Co.	Conroe, Texas	Oil Pump	CB	1	25	500	2	5½	7	2	.....	Nat	....
Morning Starlight Dairy	Detroit, Mich.	Ref Comp	Cont	1	22	1350	4	3 7/16	4⅜	4	12,000	Nat	1014
Crown Ice Cream Co.	Detroit, Mich.	Ref Comp	Cont	1	18	1100	4	3 7/16	4⅜	4	12,000	Nat	1014
Noble Mfg. Co.	Cedartown, Ga.	Papermill	Chev†	1	15	900	6	....	....	4	13,000	Nat	980
B Shupenka	Detroit, Mich.	Air Comp	Chev†	1	10	1000	4	....	....	4	15,000	Nat	1014
Mehlhose Ice Cream Co.	Detroit, Mich.	Ref Comp	Ford†	1	10	800	5	3⅜	4¼	4	14,000	Nat	1014
Bodker Dairy	Detroit, Mich.	Ref Comp	Cont	1	7	1180	4	2½	3½	4	12,000	Nat	1014
Enfanla City Water Works	Enfanla, Okla.	Pump	Ford†	3	25	1400	8	3.2	3¾	4	.....	Nat	1050
Apex Battery	Chicago, Ill.	Gen	Int	2	25	1000	4	4¼	5	4	.....	City	800
Greggson Tool & Die Co.	Chicago, Ill.	Gen & Shaft	Ford†	1	20.6	1200	4	3⅜	4¼	4	.....	City	800
W T Hale	Oklahoma City, Okla.	Pump	Buda	1	20	1200	4	3.8	4¾	4	.....	Nat	1050
Royal Battery Co.	Chicago, Ill.	Gen	Hup†	1	17.5	900	6	3¼	4⅛	4	.....	City	800
Hamilton Grill	Chicago, Ill.	Comp	Chry†	1	16.8	1200	6	3⅛	4⅜	4	.....	City	800
Wooster	Ohio	Pump	Cli	1	15	720	4	4½	5¼	4	10,000	Sew	600
State College	Pennsylvania	Gen	Cli	1	15	720	4	4½	5¼	4	11,000	Sew	600
Medford	Wisconsin	Gen	LeRoi	1	10	955	4	3⅛	4½	4	11,000	Sew	600

ABBREVIATIONS—AC — Allis-Chalmers, CB — Cooper-Bessemer, Cli — Climax Engrg, Cont—Continental Motors, Int—International Harvester, IR—Ingersoll-Rand.
Under type of fuel: City—city gas, Nat—natural gas, Sew—sewage gas.

† Converted automotive or marine engines, including Buick, Chevrolet (Chev), Ford, Chrysler (Chry), Hupmobile (Hup), Lincoln (Linc), Scott-Hall (Hall).
* Horizontal units, all others vertical.

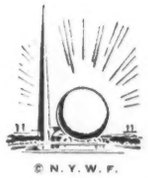
Everdur Tank brings three new "R's" to school!

1,000-gallon Everdur heater fabricated by Eastern Steel Tank Corporation, Brooklyn, N. Y., for Central School, Wappinger Falls, N. Y. Don P. Emley, Poughkeepsie, N. Y., Architect.

BECAUSE the new Central School at Wappinger Falls, N. Y., has an Everdur heater, the hot water will never be tainted with tank-rust... either now or in the years to come. And with a heater so dependable, so long-lived, the user can be sure that repair bills will be held to a minimum. Surely an important advantage to schools, hospitals and other institutions, particularly where operating budgets are limited!

Everdur—The American Brass Company's copper-silicon alloy—is absolutely rustproof. It is strong and tough. It welds readily. For a quotation on an Everdur heater for any requirement, just ask a leading equipment manufacturer. You may be surprised at the moderate cost of a heater with such desirable properties: Remember the name—*Everdur!*

4057



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Visit the Copper & Brass Industry Exhibit in the Hall of Industry, New York World's Fair—1940

Everdur TANK METAL

ANACONDA from mine to consumer

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT

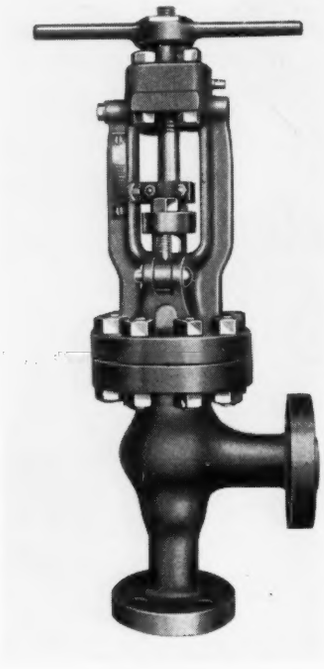
In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont. • *Subsidiary of Anaconda Copper Mining Co.*

"EVERDUR" is a trademark of The American Brass Company, registered in the United States Patent Office.

WHAT'S NEW IN PLANT EQUIPMENT

Multi-Stage Valve for Continuous Blowdown

MULTI-STAGE THROTTLING VALVE for continuous blowdown of high-pressure boilers has cone-shaped poppet with scientifically curved grooves forming series of contact lands with converging walls of seat. When valve is cracked during opening or closing, pressure is stepped down by easy stages to reduce wire drawing and prevent erosion. Metering pin extending from end of plug acts also as needle valve. This is centered



between walls of venturi seat to control size of orifice without hindering smooth flow. Pin is said to meter accurately flow of water to meet operating conditions of boiler. Additional features of valve include tightness due to correct application of labyrinth principle which water-seals closure, self-cleaning and self-burnishing, multiple-ring seating contacts which cannot be injured by scale.

Ludlow Valve Mfg Co, Troy, N. Y.

Floor Seal

BAKEFLEX is made with Bakelite, to give it moisture-and stain-resisting characteristics. Designed for use on all types of floors likely to acquire stains, dirt, etc. Floors coated with Bakeflex said to be resistant to cigarettes, alcohol, fire, acids of some types, and other staining agents. Surface should be relatively clean before application, unless preservation of floor is more important than appearance.

Flexrock Co, 23rd & Manning St, Philadelphia, Pa.

Flexible Tubing

SEAMLEX bronze tubing can be bent to a radius of 6 in. if necessary. Covered with bronze braid jacket, manufacturer states, it will withstand a safe internal working pressure of 150 lb psi. Suitable for conveying steam, water, oil, gas, air, etc.

Seamlex Co, Inc, 5-17 48th Ave, Long Island City, N. Y.

Water Refining Unit *(bottom)*

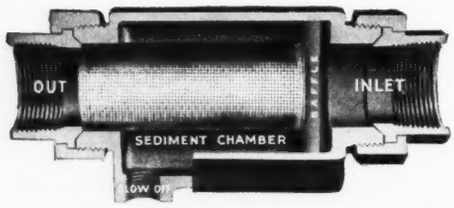
MOBILE UNIT for use of U S Army and Marine Corps have capacity of 100 and 50 gpm respectively. Each unit has gasoline-driven centrifugal pump, direct gas-fed chlorinator-soda ash feeder, alum feeder, and American Co filter. Unit is equipped with instruments for proper control, interconnected piping and metal reinforced rubber hose. Test sets also available for determination of turbidity, alkalinity, and chlorine content of refined and raw water. Units will be mounted on trucks and trailers by company for military use.

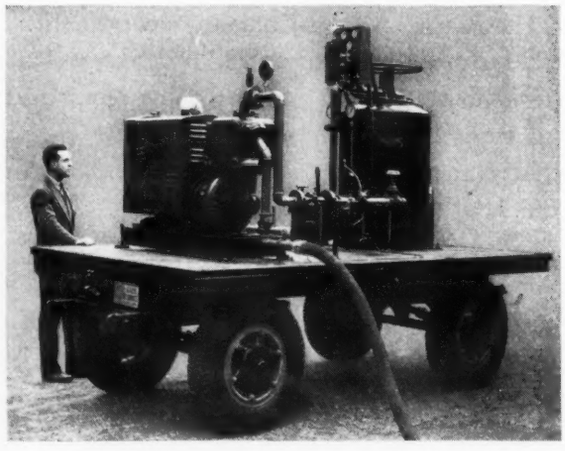
American Water Softener Co, Philadelphia, Pa.

Strainer

"EASYCLEAN" strainer made for steam, air, gas, oil or water. Features claimed by maker include easy connection as union to pipeline, and easy to keep clean. Dirt pocket in bottom of strainer collects dirt and scale before reaching screen. When cleaning becomes necessary, union is opened, strainer is slipped out, cleaned and replaced.

Wright-Austin Co, W Woodbridge St, Detroit, Mich.





Speed Control

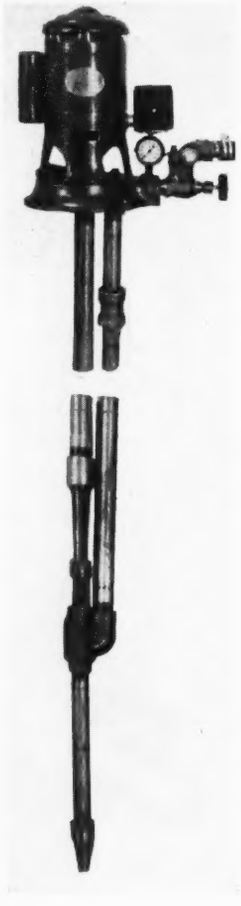
SEVERAL CHANGES made in JFS-Jr speed control. These include long bronze bushings on center pulley halves which slide on rotating shaft, and changes in universal base structure. New bushings can be inserted to renew drive, instead of needing entire machined pulleys. Universal base which can be changed in position depending on relationship of drive and driven pulleys is mounted on sub-base which is at right angles to rotating shaft, rather than at an angle, as was formerly the case. Changes have been made in first three sizes of controls.

Columbia Vari-Speed Co, Wheaton, Ill.

Ejector Pump

DEEPWELL, 2-pipe ejector pumping system consists of vertical, volute pump, close-coupled to a 3500-rpm, 110-220-volt, 60-cycle single-phase motor, placed above ground and connected by two pipes to ejector, near or below the water-surface level in well. Part of water pumped flows down one pipe through ejectors and serves to lift water from well to within suction limits of volute pump. Practical suction lift of volute pump is 20 ft. Ejector pump can be used for lift up to 110 ft. For wells smaller than 4-in. inside diameter, single-pipe ejector system is used. This system

(Continued on page 134)



YOUR *SPECIAL SERVICE* VALVES ARE *REGULARS* IN THE CRANE LINE

THIS NEW CATALOG HELPS YOU CHOOSE

✓ *Dependable*

✓ *Low-Cost*

PIPING FOR EVERY CORROSIVE FLUID

NO LONGER need power and processing plants encountering corrosive and other reactive conditions in piping, search for *special* valves and fittings.

Now, a complete range of corrosion-resistant piping equipment is available from stock in the great Crane line. From a wide selection of alloys, you can choose with surety for every condition. There is a Crane material offering highest protective values against chemical impurities for each gas or liquid service.

Crane alloy equipment is not without experience in actual service. Heretofore available on special order only, it has for many years pleased the most exacting users in power and processing industries.

This new Crane line reflects a thorough knowledge of the efficiency of select alloys under varying working conditions. And combining Crane's ability in valve engineering and 85-year manufacturing experience, it assures you of complete satisfaction from every angle.

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MONEL METAL
NI-RESIST
18-8 MO.
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ALL-IRON

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. . . and get acquainted with Crane Corrosion-Resistant Valves and Fittings. You'll find it a reliable piping "headache" remedy and a sound money-saving manual. You will find a lot of use for the authoritative colored "Stop & Go" chart which indicates the degree of suitability of each alloy for specific services. Your Crane Representative will gladly supply this catalog—*free*—or, you may use the coupon below to get one.

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CRANE

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Please send me a copy of your Catalog No. 312. No obligation, of course.

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P-7-40

Breaking the Rules . . .

▶"THAT THERE MULE AIN'T BALKY," insisted Sambo, "He just so scared I gonna say 'Whoa' some time and he ain't gonna hear me that he stops every so often to listen!"

Sambo's mule might have had another failing that lots of humans have—the unthinking, drilled-in fear of breaking a rule. Many of us have been so bound about by rules and regulations for so long that they've become a part of us—we automatically look for some guidance in whatever we do.

Usually, rules are good things to have. They prevent the kind of experimenting that costs money—and sometimes lives. But in planning rules for your plant, leave a little loophole for the initiative that can keep the spark of progress alive.

Some things must be done by rule—like starting up or shutting down an engine. But there are lots of places where present methods could be changed—if somebody just had the nerve to forget what grandpa did back in the good old days.

Someone, wise in the ways of handling men, once said, "Management is the art of knowning when to *break* a rule."

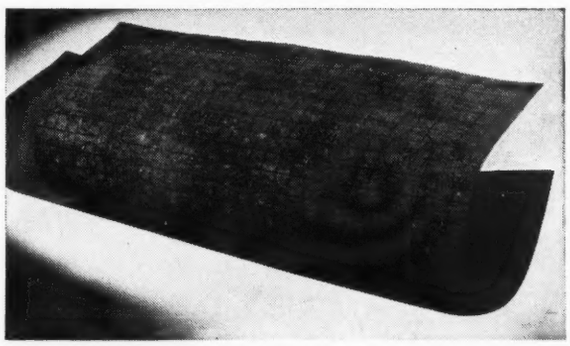
I submit that as a good motto to hang over your desk.

George Edwards

Engineer

KEEPING 'EM ROLLING — By WESTCOTT

JOE'S METHOD . . . *Cut Down Replacements by Using J-M Service Sheet*



J-M SERVICE SHEET (Style No. 60): J-M Service Sheet has proved its durability under the most difficult operating conditions. One side is graphited; the other plain and ruled to make measuring and cutting easy.

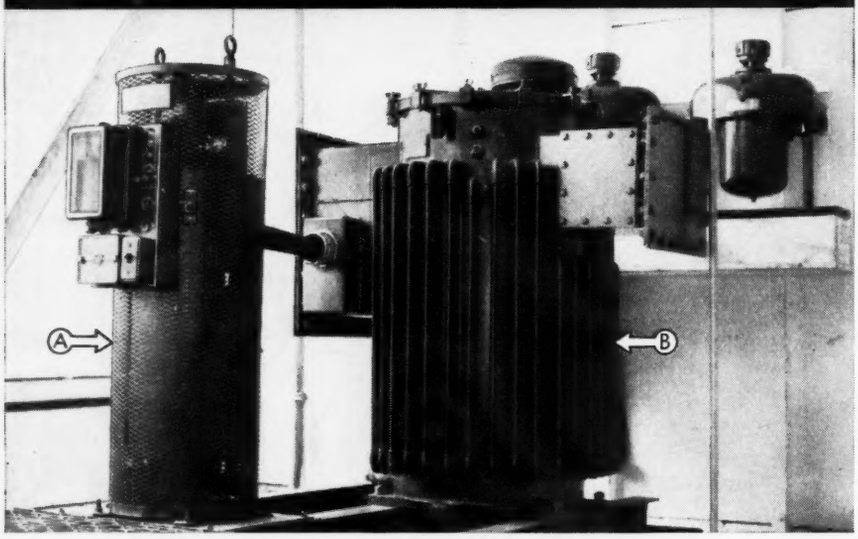
MANY gasket failures boil down to just one thing—inferior sheet packing. A good percentage of them are as unnecessary as they are expensive. For in J-M Service Sheet, you get a tough asbestos material that lasts longer under practically all operating conditions. It is dense, yet resilient, and, most important, it is always uniform in quality. Stock it as long as you wish—it does not deteriorate with age. A tryout will show you why more and more engineers are standardizing on J-M Service Sheet. For details and facts on the complete J-M line of quality packings, send for the J-M Packing Catalog. Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

Now A G-E "REGULATOR" TO GIVE YOU BETTER LIGHTING —BETTER MOTOR PERFORMANCE



This G-E air-cooled regulator (A) in a modern factory provides precise voltage control for the lamps supplied by Pyranol transformer (B)

You know that voltage delivered at the correct level at your service entrance may fluctuate widely on your plant circuits because of varying power loads and lighting loads. You also know the advantages—in higher efficiency and increased production—of maintaining correct voltage on these circuits.

Now you can do it—economically—with the new G-E air-cooled Type AIRS regulators. They give a smooth, precise automatic voltage regulation that means better lighting, better motor performance, and better service from other electric equipment.

They are easily installed. Because they are air cooled, they require no expensive fireproof vaults. They take little space, and can be placed in out-of-the-way locations, even on beams up near the ceiling. Available in ratings from 1.2 to 12 kva, for 120-, 240-, 480-, and 600-volt circuits, and 10 per cent raise and 10 per cent lower regulation.

Find out for yourself how little these regulators cost. Ask your G-E representative for details, or write for Bulletin GEA-3057. Address General Electric, Schenectady, N. Y.

And for Testing—the Voltage You Want When You Want It

In many laboratory tests, precise voltage control is a major factor in accuracy of results. The new hand- and motor-operated Type AIRS regulators are available for a range of 100 per cent raise and 100 per cent lower, and give the exact voltage you require—at a turn of a crank, or of a switch. Complete description in GEA-3057.

GENERAL ELECTRIC

404-1

Speed As You Like It

(Continued from page 118)

speed applications are now available. The sheaves of these units are constructed so that the effective pitch diameter of their grooves can be varied readily to increase or decrease speed. The diameter-changing mechanisms of these sheaves are of two types. On one of these, stationary control, the sheave must be stopped to change its pitch diameter with a spanner wrench. In the other design, the groove pitch diameter can be changed while the sheave is running.

On drives where the sheaves are approximately the same diameter, both may be of the adjustable-diameter type to obtain a speed range of over 3 to 1. Fig. 6 shows one of these drives (Allis-Chalmers) with the adjustable sheave on the motor only. Here the sheave is used to maintain a constant cutting speed of a grinding wheel as the wheel wears down.

To adapt these adjustable-diameter multiple-groove sheaves to a wider range of speed-change applications, they have been combined into a casing with an adjusting gear to form a variable-speed-transmission unit. These units are generally used for drives where the required speed adjustment comes with their range. They have two adjustable diameter sheaves, with 1 to 4 grooves depending upon the power output and speed. Fig. 7 shows one of these units connected to a motor mounted on top of it, driving a suiting-cloth presser.

Speed control on the units described may be manual by a handwheel or other device; remote from push buttons, or automatic from any actuating source such as a change in pressure, temperature, flow, floating roll or other means. These units may also be used to synchronize the speeds of different machines or of separate machines. Control impulses may be transmitted mechanically, electrically or hydraulically.

Air Interrupts

(Continued from page 83)

sients, caused by dissipation of system stored energy, which are superimposed upon the normal-frequency recovery voltage. This reduces the rate of rise of recovery voltage immediately after fault interruption and limits the possibility of arc reignition.

When closing, electrically or manu-

Chapman

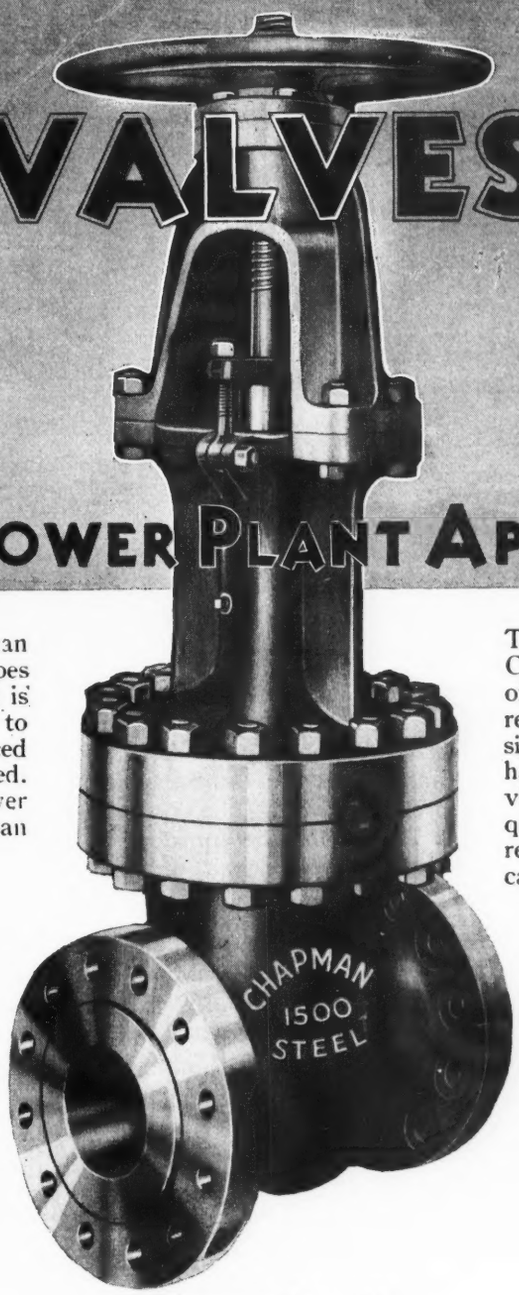
VALVES

FOR ALL POWER PLANT APPLICATIONS

The standard lines of Chapman Valves include a range of types and sizes so complete that it is only a matter of selection to secure the best valve produced for the type of service involved. For application in the Power Plant field, there is a Chapman Valve for every need.

These valves are available in all types; gates, globes, angles and checks. And in metals best suited to the specific service involved; bronze, iron, steel or alloy.

For low pressure service, boiler feed lines, and applications involving normal pressures and temperatures, Chapman Iron Body valves are recommended for long service and economy.



Chapman List 1500
Solid Wedge Steel Gate Valve
1500 pounds at 750 degrees F.

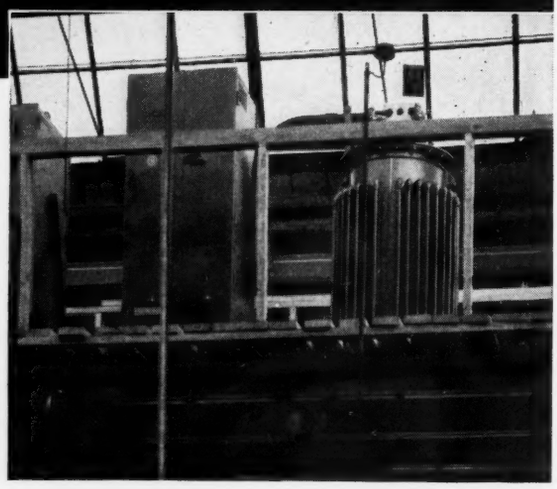
The design and manufacture of Chapman Valves represent years of painstaking development and research. Every detail of design, workmanship and material has been perfected to meet service conditions, and proved adequate by actual performance records in all fields of application.

For high pressure and high temperature service, a full line of Cast Steel Valves is available, covering a range of pressures to 1500 pounds and temperatures to 1000 degrees Fahrenheit. All types and sizes, in carbon steel or alloys to meet any specific service condition in modern Power Plant practice, are included in these standard lines of Chapman Steel Valves.

THE CHAPMAN VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASS.

Here's a Profit Tip--

Put G-E PYRANOL Transformers at Load Centers



-- for Savings Like These

1. "We saved $500 on installed cost by using a Pyranol transformer to supply a lighting load," says R. H. Lewis, electrical superintendent of the Motor Wheel Corporation, Lansing, Michigan. This saving was possible because a fire-proof enclosing vault—which would have been required with an oil-filled transformer—was unnecessary, and because floor space was saved by mounting the Pyranol transformer on an overhead platform. By placing the transformer right at the load center, the cost of running a heavy three-wire secondary for 500 feet was also avoided.

2. The Byron Jackson Company, Los Angeles, installed a bank of three 200-kva Pyranol transformers in space that could not be used for production. The non-inflammable feature of Pyranol enabled this company to save the cost of building in the production area of the plant, an underground vault, which would have been required with oil-filled transformers.

3. Putting a Pyranol transformer at the load center cut feeder costs 50 per cent on a lighting circuit in the new recreation building of an Alabama cotton mill.

Find out for yourself how you can save on power- or lighting-circuit installations by installing G-E Pyranol transformers indoors at load centers. After installation you will get daily dividends in the form of reduced copper losses, better voltage regulation. Ask your G-E representative for complete information, or write today for Bulletin GEA-2637. Address General Electric, Schenectady, N.Y.

GENERAL ELECTRIC

402-4

ally, actuation of closing valve V_2 admits compressed air to closing cylinder above piston P_8, Fig. 5. Downward movement of this piston closes isolating contact D which completes the circuit, arcing contact C being already closed. Thus, any occasional slight contact burning which may take place during the closing operation will be on separate contacts from those used for arc interruption. This divides the contact wear.

Due to the high speed at which the isolating contacts close, burning during closing is very slight. During interrupting tests, a 1200-ampere breaker was closed against a peak current of over 140,000 amperes without appreciable burning or pitting of the contacts.

Simple Interlock

A simple mechanical interlock insures that all switching operations, once initiated, will be completed. A mechanical trip-free device permits immediate reopening of the isolating contacts if they happen to be closed against a short circuit, even though air pressure may still be applied to the closing piston.

The interrupting contacts can be moved independently of the isolating contacts when required. This is of particular advantage, especially in higher-voltage outdoor breakers, since by opening and reclosing only the arcing contacts very short interrupting and reclosing times can be obtained.

Functions Divided

It is to be noted that the interrupting and isolating functions of the breaker are divided between arcing contacts and isolating contacts respectively. This permits opening the interrupting contacts only the short distance which tests have proved gives maximum interrupting efficiency. Separation of the interrupting and isolating functions also permits reduction in relative size of the arcing contact assembly to the point where its inertia is negligible when compared with the energy available in the compressed air. Very quick opening of the arcing contacts, which further contributes toward efficient interruption, is thereby obtained.

Owing to the oilless feature, and to the simplicity, compactness, and flexibility of its design, this new circuit breaker can be mounted at practically any angle and in a wide variety of arrangements so far as its component parts are concerned. It is applicable to metal-clad switchgear and can be rendered entirely satisfactory for outdoor service.

"Mike" Speed of Eagle-Globe-Royal Indemnity Co. and Herman Dost, Chief Electrician of Pennsylvania Sugar Co., on a periodic "sleuthing expedition" to detect faulty insulation . . . they keep Pennsylvania Sugar's big generators running.

Quick, Watson, The "MEGGER" Tester

"Every Saturday before and after our week-end cleaning, the 'Wizard' (that's what we call Herman Dost) applies our 'Megger' Tester to all of our important generating equipment. Usually nothing happens, except that some figures are added to our records of insulation resistance.

Then one day the 'Megger' test indicates that somewhere there's a leak. Maybe an innocent wire has rubbed against a jittery frame and, like the surgeon's X-ray, the 'Megger' test detects the condition and a failure is forestalled.

With our insulation resistance records, we further watch any progressive weakening of the 'arteries' and have warning that permits us to make repairs at convenient times, rather than tie up all or part of our plant. Newly wound motors and wiring installations also have to submit to the 'Megger' test and not infrequently a blow-up is thereby averted.

A maintenance gang without a 'Megger' Tester would be like a hospital without an X-ray machine."

DAN GUTLEBEN,
Chief Engineer at the Pennsylvania Sugar Company's Philadelphia Refinery.

"MEGGER"
Trade Mark
Reg. U. S. Pat. Off.

Any one with an equal determination to forestall trouble can match this splendid record and enjoy similar freedom from power failure and unnecessary repair bills. Write for our New Bulletin 1655-P on Getting Results with "Megger" Insulation Testers.

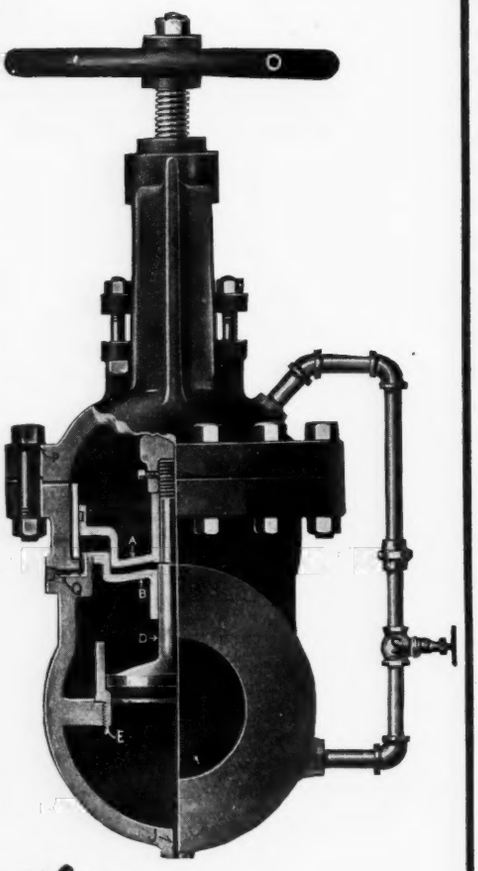
JAMES G. BIDDLE CO.
1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

GOLDEN-ANDERSON

Specialty

VALVES

THROTTLE AND EMERGENCY STOP



● With G-A's throttle and emergency stop valve, you're assured of protection against damage to valuable property, for it automatically shuts down any over-speeding engine or turbine. It works instantly . . . mechanically, electrically, or by hand . . . even to being tripped by a push button from remote points. No unit can exceed safe operation speed when equipped with this valve, as maximum speeds are rigidly controlled. Comes in angle and globe patterns from 2½" to 16" in size. You'll find these quality G-A valves in use, under every pressure, on all types of steam engines and turbines. For a more detailed description of the complete G-A line, write for our free catalog today.

also

Triple Acting Non-Return . . .
Altitude Control . . .
Float Control . . .
Pressure Reducing . . .
Check Valves, etc.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

New Plant Equipment

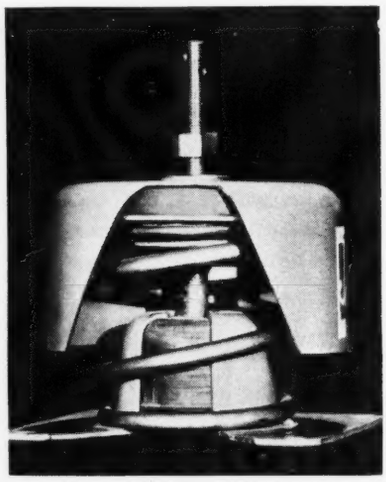
(*Continued from page* 128)

uses well casing as ejector pressure-pipe with the suction pipe in the center. Well is closed by a fitting into which ejector pipe from discharge pipe connects. Well packer below ejector seals suction pipe into well so that water passing down inside well-casing can pass through ejector only. Pumps can be used in wells 2-in. inside minimum diameter. Pump capacities range up to 60 gpm and lifts up to 110-ft. At reduced capacities, discharge pressures up to 50 lb per sq in. may be used.

A D Cook, Inc, Lawrenceburg, Ind.

Spring Isolator

WORKING PARTS of J-M controlled-spring isolator consist of coil spring and rubber load pad, which support the equipment and isolate vibration, and adjustable rubber snubber inside base, which controls

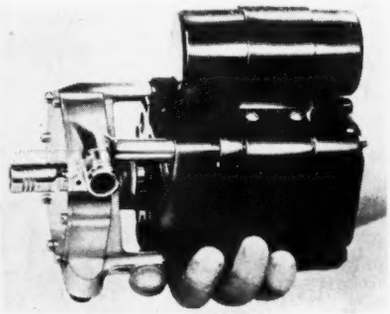


excessive motion. Through combination of these parts, manufacturer says, isolator provides both high compliance necessary for good isolation and control needed to limit motion in the equipment.

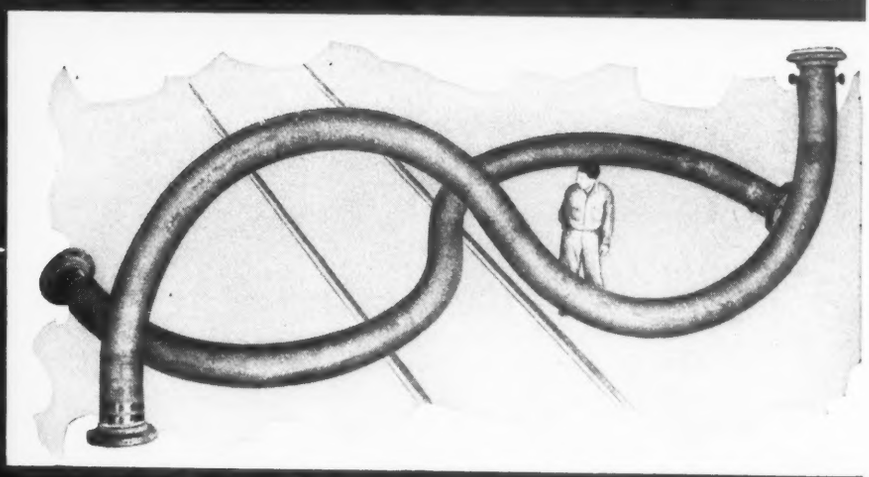
Johns-Manville, 22 East 42nd St, New York, N. Y.

Midget Centrifugal Pump

MODEL D MIDGET is designed for use in all industrial plants, laboratories, etc, where thin liquids are to be handled. Unit



MIDWEST *Alloy* PIPING



14" O.D. Chromium-Molybdenum pipe bends with Van Stone laps. Entire bends annealed after fabrication.

Carbon-Molybdenum header stress relieved in furnace before welding on valves which were welded by preheating and stress relieving with induction method.

PRESSURE piping users have found that alloy tubing presents many problems and difficulties not encountered when low carbon steel materials are used. Some have learned by bitter experience that the utmost care must be exercised in selecting a fabricator . . . one who has wide experience in the special manufacturing procedures required by the various alloys. It is also essential that the fabricator's welders be skilled on welding alloy tubing . . . and that he have the heat treating furnaces and other special equipment needed.

Each of the three Midwest plants is thoroughly familiar with all the "do's" and "don'ts" peculiar to the fabrication of alloy tubing. Midwest has welders qualified on the alloys . . . and Midwest has the special equipment so essential to the successful fabrication of alloy tubing.

Whenever you need alloy piping, you will find it definitely advantageous to get in touch with the nearest Midwest office.

MIDWEST PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 S. Second Street, St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • *Sales Offices:* Chicago—946 Marquette Building • Houston—1716 Second National Bank Building • Los Angeles—520 Anderson Street • New York—(Eastern Division) 30 Church Street • Tulsa—533 Mayo Building.

ADVERTISING PAGES REMOVED

Introducing -

Old friends in a New Dress

★ *New Refinements*
★ *Proved Performance*
★ *Smartly Styled Cases*

New Refinements have been made in basically sound, proved-in-service features which may appear to be "new" but which were first offered by Mason-Neilan over five years ago. Four basic forms of control for pressure, temperature, flow, level or ratio; interchangeable, in the field if desired, by means of standard parts with a minimum of effort. On-and-off and throttling control combined in one instrument.

Four Forms of Control which have been featured by Mason-Neilan since 1935 and proved by performance on the job:

1. On-and-off: Secured with any of the following standard control units without extra parts. Cut-in by a simple adjustment.

2. Single Compensated: Adaptable to 90% of all industrial applications. Only systems with severe load changes and unfavorable time lag require a more specialized controller. Direct Setting.

3. Dual Compensated: Basic controller with the addition of instantaneous or delayed reset action from a secondary medium. Direct Setting. Exclusively Masoneilan.

4. Drift Compensated: Basic controller with the addition of automatic, adjustable reset. Adaptable to systems having unfavorable time lag and sustained load changes. Direct Setting.

All Adjustments Made Without Disturbing the Chart Record. All adjustments required for synchronizing the instrument with the process, in reversing the action of the controller, in checking-up the pilot system or in actually removing the pilot if necessary, are made without disturbing the chart record or interrupting the function of the controller.

Before buying any controllers investigate these modern Masoneilan instruments.

MASONEILAN

MASON-NEILAN REGULATOR CO.
1186 ADAMS ST., BOSTON, MASS., U. S. A.

New York Buffalo Philadelphia Pittsburgh Chicago
St. Louis Tulsa Houston Los Angeles
Mason Regulator Co of Canada Ltd., Montreal

weighs 14 pounds, and is 7¾-in. x 6⅜-in. x 5¼-in. Maximum pressure is 17 lb psi, and total capacity is 5 gpm. Motor armature and pump impeller are mounted on single shaft, eliminating necessity for intermediate coupling.

Eastern Engrg Co, 45 Fox St, New Haven, Conn.

Ring-Balance Meter

MECHANICAL ring-balance meter can be used for metering steam, water, gas, air, etc, at static pressures up to 1000 lb psi. Meter is said to give full scale readings

on differentials as low as 3-in. of water, and is easily adjustable. Furnished with any combination of indicator recorder and cyclometer-type integrator.

Republic Flow Meters Co, 2222 Diversey Parkway, Chicago, Ill.

Metal Joiner

COLAWELD METALJOINER eliminates difficulty of joining aluminum and aluminum alloys to each other, as well as speeds up joining of other metals, such as steel, copper, brass, Monel, stainless steel, etc. Joint produced is result of fusion of molten Colaweld with each and alloying deposition of compound with surfaces of base metals to be joined. Application consists of applying compound to surface of metals to be joined, placing metals together and applying heat. Only low heat is required, says the maker, and this can be applied by flame, hot air, oven, iron, etc. When compound is actuated by heat, white fumes will be given off and the metal in the compound will melt. After this occurs, excess compound should be cleaned off, joint be cooled by air or water, and job is finished.

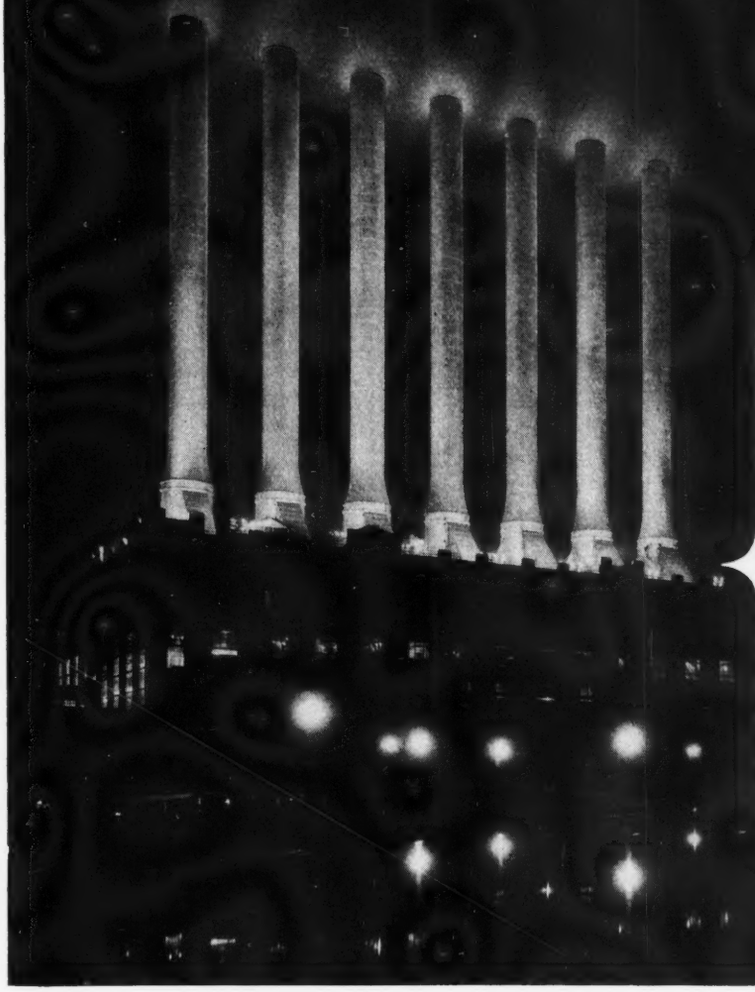
Colonial Alloys Co, Colonial Philadelphia Bldg, Philadelphia, Pa.

Mercury Clutch

UTILIZING MERCURY to displace friction segments by centrifugal force, clutch gradually picks up the load at full speed. In operation, mercury displaces clutch segments inward, where they engage the drum at proper time and speed, a positive drive being effected where speed of hous-

(*Continued on page* 142)

A DREAM COMES TRUE!



WITH EFFICIENT, ECONOMICAL COAL

DETROIT EDISON

MAKES *ONE* POUND DO THE WORK OF *THREE!*

● Improvement in power plant efficiency—indicative of what can be done today with COAL—made it possible for The Detroit Edison Company during 1939 to generate each kilowatt-hour of net output with less than 1/3 as much coal as was required 30 years ago. This great achievement is a tribute to their engineers—and also a tribute to the modern efficiency of our most dependable fuel—*coal*.

During 1939, Detroit Edison used 1,416,622 tons of bituminous coal from mines in Kentucky, Virginia and West Virginia—"The Coal Bin of America." From this region comes coal for every need—with one of the world's best-equipped railway systems available to bring it to you.

"The Coal Bin of America" is served by Chesapeake and Ohio Lines, largest originating carrier of bituminous coal in the country. When it comes to coal, our main job is providing dependable delivery from mines to users. But our Fuel Service Engineers are also at your service — to help you get the particular coal you need, prepared to your order.

For information or assistance with fuel problems, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, O.

CHESAPEAKE AND OHIO LINES

Fig. 0850
250 lbs. steam pressure

Having a revolving ball plug, instead of the usual wedge or disc, the Fairbanks Sphero offers many advantages possessed by no other valve.

It positively eliminates frictional resistance to stream flow, as the round opening in ball plug is the same size as that in the pipe. When the ball plug is opened or closed, it wipes seating surfaces clean. Its shearing action cuts through heavy solids and liquids that would cause ordinary valves to stick and jam. There is nothing on which scale or foreign matter can accumulate.

A positive shut-off is assured as the seat rings form a perfect fit with the ball. A wedge permits adjustment to make the seat rings absolutely pressure tight. And wear on seat rings is reduced to a minimum by the rotary movement of the ball.

A quarter turn of the lever handle opens or closes the valve "as quick as a wink". And you can always be certain that it is fully open or shut tight because it has a positive stop.

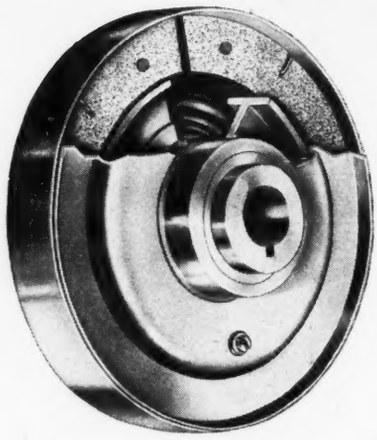
When seat rings or other parts become worn, they can be replaced without removing the valve from the line.

No other valve gives such ideal service for blow-off purposes or where a full-flow, quick acting valve is required.

Write now for catalog No. 21 and name of our nearest distributor.

THE FAIRBANKS COMPANY
Valves, Dart Unions, Hand Trucks and Wheelbarrows
397 Lafayette St., New York, N. Y.
Boston, Pittsburgh—Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks Sphero Valves



ing and driven drum are synchronized. Overloads and other shocks are said not to be transmitted through clutch to prime mover, because clutch capacity limits torque transmitted.

Mercury Clutch Corp, 637 W 3rd St, Massillon, Ohio

Boiler-Feed Treatment for Silica Removal

PRESENCE OF SILICA in boiler-feed water—specially for modern high-pressure, high-temperature installations—is recognized as one of the most serious problems facing power-plant operators today. Newest aid in combatting this problem is "Adsorption Process," utilizing Remosil (specially prepared magnesium oxide), which reduces soluble silica in any natural water to a fractional part per million while actually reducing rather than increasing the total solids in the water. Silica is removed in the hot-process softeners; no expensive additional equipment is required.

Other features listed for this new process include: (1) unnecessary to use other coagulants in softening operations, (2) causes no increase in requirements for lime and soda ash, but rather effects lower hardness and alkalinity than would otherwise be possible, (3) "Adsorption Process," utilizing solely one chemical, permits addition of lime for softening operations when needed entirely independent of any magnesium requirements for silica control. Patents have been applied for.

W H & L D Betz, 235 W Wyoming Ave, Philadelphia, Pa.

Oil Flusher

PORT-O-FLUSH, portable pressure oil flusher and dispenser, is used in cleaning and flushing bearings on machines, etc. Oil is introduced to bearing at 60 to 100 lb psi by means of air or gas pressure. Unit is portable and self-contained, no pressure connections being necessary. Pressure is obtained by means of small supercharger which has carbon dioxide gas

yes—PITTSBURGH PIPING'S workmanship is excellent. Our piping system went together accurately and was completed on schedule.

MODERN piping systems with their numerous auxiliary equipment, valves, etc. place more and more emphasis on *accurate* fabrication within very close tolerances. At Pittsburgh Piping such accuracy begins in the engineering department where every job is carefully planned and the layout is detailed for efficient shop fabrication. By pre-fabricating assemblies as large as shipping facilities and installation space will permit, testing, insurance inspection and final erection are greatly simplified and expedited.

Construction time is further saved by scheduling all work through the shop in direct relation to the sequence of erection in the field. Expensive waiting periods for material are eliminated, work progresses smoothly and the installation is completed as scheduled in a pre-arranged construction program.

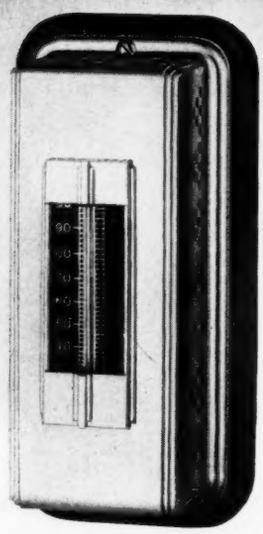
When contemplating your next piping program, get in touch with your nearest Pittsburgh Piping representative, listed below, for efficient fabrication.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Building, New York
Public Square Building, Cleveland
Occidental Building, Indianapolis
Liberty Life Building, Charlotte
Peoples Gas Building, Chicago
10 High Street, Boston
Union Guardian Building, Detroit
525 Market Street, San Francisco

Pittsburgh Piping

GRADUAL CONTROL THAT IS G-R-A-D-U-A-L



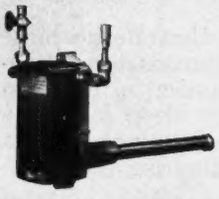
Johnson Room Thermostat with adjustable sensitivity. Eliminates "hunting" and departure from control point.

Johnson "Absolute-positioning" pilot operated Damper Motors with two diaphragms, insuring precise positioning of dampers. No springs.

"Streamline" Modulating Valves, another exclusive Johnson development, with seamless metal diaphragms and unique throttling characteristics.

Johnson "Piston" Damper Motors, affording long-travel at full power, a feature not found in other damper motors. Available with or without pilot mechanism.

"Absolute-positioning" Modulating Valves, with Johnson pilot mechanism and "Streamline" gradual control characteristics. Maximum power for re-positioning at slightest command of controlling instrument.



Insertion and Immersion Thermostats with Johnson's distinctive sensitivity adjustment, calibrated on the job to balance "time-lag" against the capacity of the controlled apparatus.

JOHNSON
PRECISE SYNCHRONIZING

Every device pictured here brings you a new conception of precision, greater flexibility, and increased understanding of what you may expect from Johnson's modern automatic control equipment . . . The Johnson line of pilot operated apparatus, for truly modulated operation by Johnson gradual acting instruments, with adjustable sensitivity, is the very latest "word" in precise synchronizing of control devices. Ask to see a Johnson engineer from a nearby branch office or send for detailed bulletins. Johnson Service Company: Milwaukee, Wis., and direct branches in all principal cities.

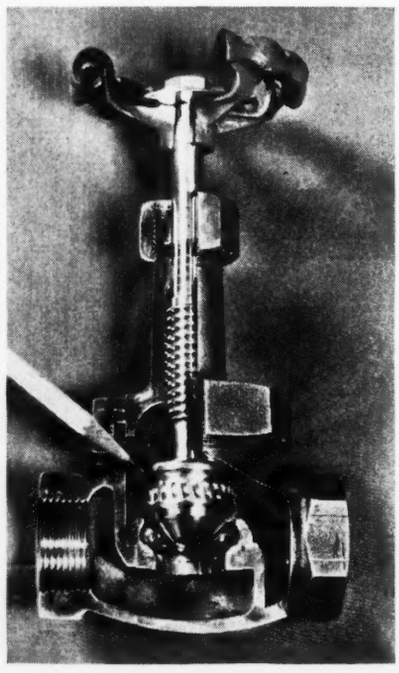
JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING *Control*

in it at 1000 lb psi pressure. After filling container with quart of oil, charger is inserted into housing. Will handle oils of all viscosities, according to maker, from kerosene to 600 W transmission oil.

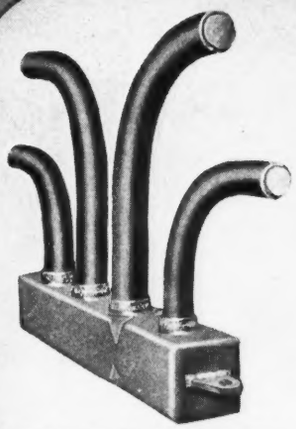
J A Honegger, 223 Spruce St, Bloomfield, N. J.

Steam Valve

OSTLIND valve is designed to eliminate causes of leaky valves rather than to resist them, according to manufacturer. Uses spinning-disk principle to maintain metal-to-metal contact between seat and disk. Disk is mounted on spindle against stainless-steel thrust bearing aligning disk with seat when closing. This bearing will stand 950 deg F, maintaining hardness

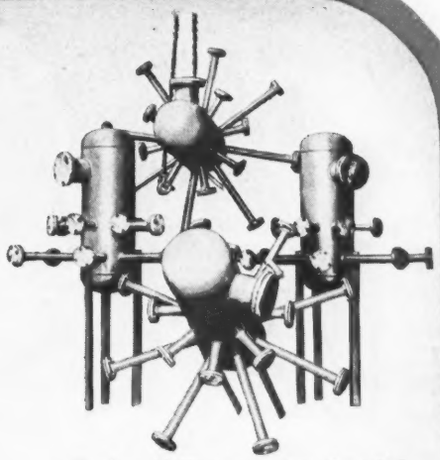


of 60 Rockwell C. Turbine vanes on top of disk are shielded from steam flow when valve is open. Just before closing, these vanes will be hit by flow directed to them by reversing chamber, causing disk to spin at the closing moment. This spinning motion causes all scale and foreign particles to be thrown off, preventing them from being caught in line of seating. Disk



Main Boiler Feed for 2000 lb.—320° F

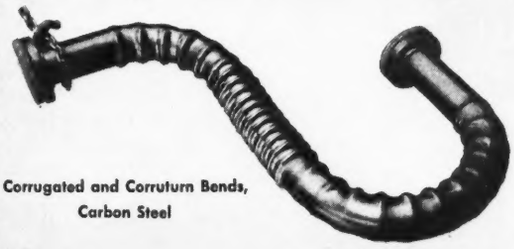
Spherical Steam Header for 1250 lb.—925° F



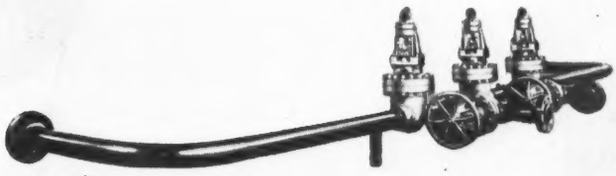
Headers with 17 accurately located nozzles—"Masterwelded"

Prefabricated pipe assemblies for 1350 lb.—950° F

8" boiler leads—with 6" by pass connections—1750 lb.—450° F



Corrugated and Corruturn Bends, Carbon Steel



6" Steam Header for 725 lb.—825° F

THEY MAY LOOK FUNNY BUT— THEY'LL ALL DO A REAL JOB

These strange shaped, odd looking examples of Kellogg prefabrication skill illustrated above were each fabricated to overcome some difficult and specific piping problem.

By completing as many of the fabricating operations as possible in the Kellogg plant, field welding is reduced to a minimum.

Consult a Kellogg engineer on all piping problems involving intricate design, high pressures and high temperatures.

KELLOGG

THE M. W. KELLOGG COMPANY

JERSEY CITY • NEW JERSEY • 225 B'WAY, N. Y.

REPRESENTATIVES

CHICAGO: 122 SOUTH MICHIGAN AVENUE

LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

"**Masterflex**" Prefabricated Piping Systems · "**Masterweld**" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic Cracking Units. Thermal and Catalytic Polymerization Units · **JUIK Processes** for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys.

The SCAIFE Man is a good man to consult when boiler water is your problem! Use his broad experience in determining the most practical and economical means of conditioning *your* feed water—for *safe operation, higher efficiency, lower maintenance costs.*

FOUNDED SCAIFE 1802

WM. B. SCAIFE & SONS CO.

General Offices, Laboratory and Works—OAKMONT, PA. (Pittsburgh District)

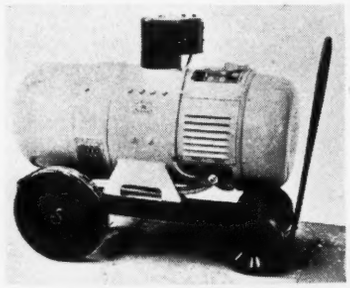
Representatives in Principal Cities

hits seat spinning at high speed, polishing line of closure and creating metal-to-metal contact.

Ostlind Valve Co. Portland, Ore.

Start-and-Stop Device

DESIGNED to eliminate waste incurred from frequent idling of arc welder between jobs, device keeps generator running only while operator touches work with electrode holder. When welding is inter-

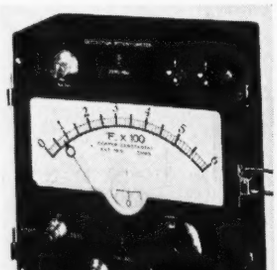


rupted, machine stops automatically after short time delay. For use only on Hornet model welder, device is operated by replacing handwheel on machine with reversible motor-driven remote-control device.

Wilson Welder & Metals, Inc, 60 East 42nd St, New York, N. Y.

Potentiometer-Pyrometer

MODEL 70-PO instrument measures temperatures by means of thermocouples in otherwise inaccessible places. Instrument uses no standard cell. Patent-applied-for circuit requires only flashlight cell. Special microammeter features automatic cold-



junction compensation inside case. Thus no adjustment has to be made for change in room temperature. Instrument is independent of thermocouple resistance permitting small thermocouple to be used. Thermocouples can be readily replaced. *J-B-T Instruments, Inc, 441 Chapel St, New Haven, Conn.*

Distribution Transformer

NEW TYPE transformer has several features not found on other types. Cadmium-plated 3-way terminals increase wiring flexibility, according to manufacturer. Installation can be made with ordinary tools

Welding operations on a section of a high pressure-high temperature job in the shops of Power Piping Division.

IN POWER PIPING FABRICATION

All processes in the pre-fabrication of piping by Power Piping Division are accompanied with the proper scientific control necessary to meet the most critical interpretation of current specifications. Such engineering procedures, established by long experience, insure customer satisfaction and confidence.

A NEW BOOK

Soon ready for publication FLEX-ANAL CHARTS by E. A. Wert and S. Smith, sponsored by Power Piping Division of Blaw-Knox Co.

It is now possible for engineers using this book to figure stresses in high pressure-high temperature piping systems by means of graphs and highly simplified formulae. This book is priced at $3.00 but will be sent gratis to engineers who ask for it on their business letterheads.

Control for the work includes where specified:

CONTROL IN BENDING.
CONTROL OF ANNEALING.
CONTROL OF GRAIN SIZE.
CONTROL OF HEAT MAINTENANCE DURING WELDING.
CONTROL OF STRESS RELIEVING.
X-RAY INSPECTION.

BLAW-KNOX COMPANY
POWER PIPING DIVISION

1525 Pennsylvania Ave. Pittsburgh, Pa.

16 Ozs CONTROLS 250 Hp.

REGARDLESS of operating or water conditions

"The Entirely Different Boiler and Engine Treatment"

SAND-BANUM

That Pure Colloidal Concentrate, has unexcelled and scientific efficiency for eliminating and preventing boiler and engine scale and corrosion.

Sand-Banum avoids costly and time-consuming water analyses and shut-downs. It works while the work is in progress, and is totally harmless to men, equipment and materials; it does not carry over with the steam.

The handy, ready to use 16 oz. cans protects a 250 Hp. boiler for 30 days. Ask for proof and details of 30 to 90 day trial plan.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza — **New York City**

WESTERN SAND-BANUM CO.

Houston, Texas — *Agencies in principal cities* — Fresno, Calif.

ONLY AS GOOD as the JOB it Does!

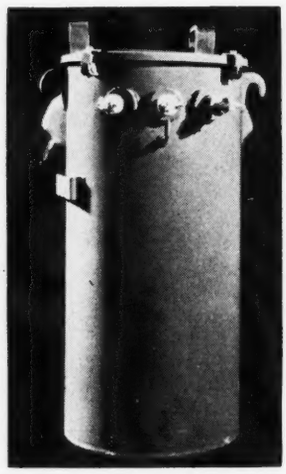
That's Lubrication-

and you'll never know its real *value* 'till your machinery *proves* it! ★ Made-for-the-Purpose LUBRICANTS keynote a *sixty-six* year Quality demonstration of our Brands of . . .

LUBRICATION

TURBINE OILS — **COMPRESSOR OILS**
CYLINDER OILS — **DYNAMO OILS**
DIESEL ENGINE OILS — **MOTOR OILS**
GREASES . . . *for every requirement.*

BORNE SCRYMSER COMPANY
ESTABLISHED 1874
17 BATTERY PLACE · NEW YORK

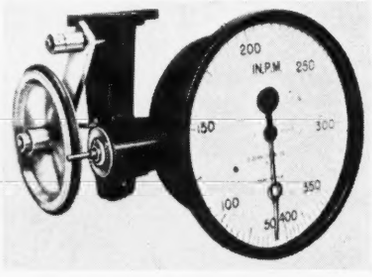


carried by lineman. Tanks are of steel tested under pressure to prevent leakage. Both high- and low-voltage bushings are said to have been designed to eliminate radio interference. Units are available in all standard N E M A ratings.

Allis-Chalmers Mfg Co, Milwaukee, Wis.

Tachometer

IMPROVED stationary tachometers show: (1) rpm, right or left, of revolving objects, such as shafts, spindles, etc, (2) surface or peripheral speed in any desired unit, inches, feet, etc, (3) speed variations occuring during a fraction of one revolution. Illustration shows tachometer adapt-

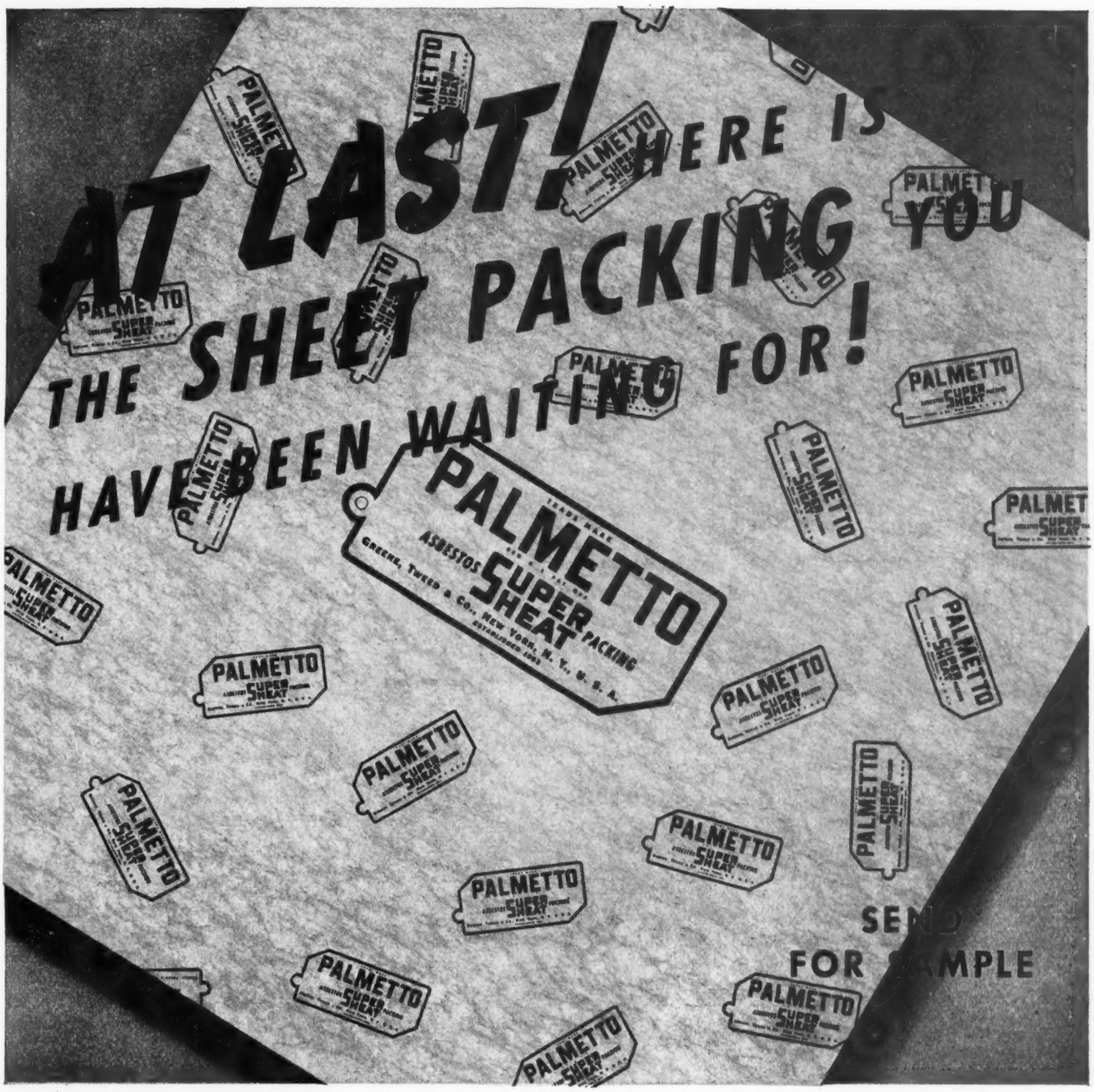


ed for inches per minute readings by means of special swinging bracket and contact wheel. Wear of rubber-tired pulley said not to affect accuracy of readings. Units may be driven in any manner, such as belt, gears, flexible shaft or coupling.

O Zernickow Co, 15 Park Row, New York, N. Y.

Plugging Switch

ALNICO magnet used as fundamental part of plugging switch for controlling motor stopping, said to eliminate frictional parts or clutches. In operation, driven Alnico



For some time past, a great many users of PALMETTO and other Greene, Tweed Packings have been asking us for a compressed asbestos sheet packing equal in quality and service to PALMETTO. We now take pride in presenting PALMETTO SUPER HEAT Packing which is available through your mill supply house . . . use it as a general "all-purpose" sheet packing with the assurance of the same long life and efficiency you have obtained from PALMETTO PACKING for over half a century.

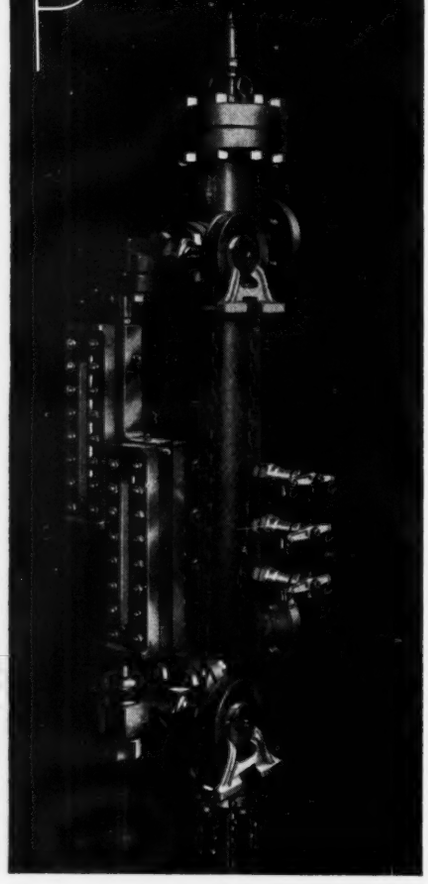
***PALMETTO**
for steam, air, hot fluids
***PALCO**
for water
***PELRO**
for solvents, oils
***CUTNO**
for alkalis
***SUPER CUTNO**
for acids

*Reg. U. S. Pat. Off.

GREENE, TWEED & CO.
SELF-LUBRICATING AND SHEET PACKINGS
101 Park Ave., New York, N. Y.
Established 1863

BE SURE TO SPECIFY PALMETTO SUPER HEAT AND BE SURE IT'S GREEN

POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1807. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

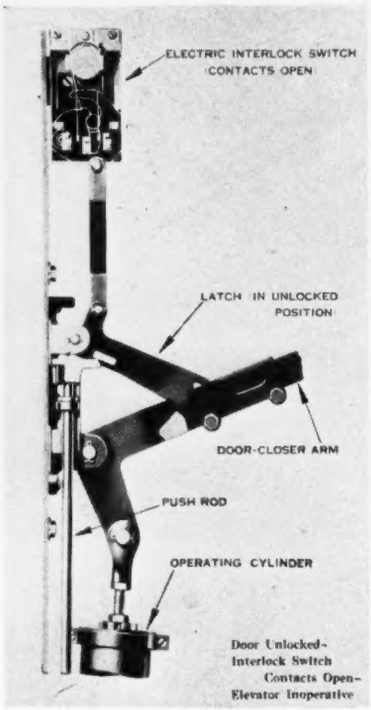
YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

rotor produces rotating magnetic field which induces eddy currents in walls of aluminum cup. Magnetic reaction produced by the eddy currents turns cup through its limited rotation, and contacts are operated by Textolite rod which connects cup and movable contact strip. As speed of motor decreases, definite point will be reached where spring force will overcome magnetic force. This is tripping point. Changing spring tension provides easy means of adjusting tripping speed over definite range.

General Electric Co, Schenectady, N. Y.

Elevator Door Closer

OTIS 4-PB DOOR CLOSER and electric interlock is designed for operation of sliding hoistway doors used with automatic elevators. When car stops at landing, car cam is automatically projected against sill mechanism. This lifts push rod (see illustration). Push rod head in turn lifts latch from engagement with door closer arm, and door may be opened. Being directly connected to interlock switch, movement of latch *first* opens interlock circuit, preventing movement of the elevator, and then unlocks door.



Otis Elevator Co, 260 11th Ave, New York, N. Y.

Valve Refacer

TYPE AAB valve refacer is said to restore seats on all makes of flat set globe, cross and angle valves. Tools are available in kits of 4 to 9 tools, sizes from ½ to 3 in. Stems or spindles of valve refacers are of same diameter as smallest stem or spindle used in any make globe valve. This allows tool to enter any valve bonnet. According to manufacturer, perfectly tight seats are obtained when tool is used with reasonable care. No lapping with grind-

REMOVE
UNDESIRABLE
SUBSTANCES
FROM BOILER
FEED WATER
with
FERRISUL

Modern high pressure steam generating plants require boiler feed water of extremely high quality, free from undesirable substances found in natural waters.

Organic matter and oily substances must be entirely removed to prevent foaming. Scale forming hardness and silica must also be removed. Total solids must be kept at a minimum.

Ferrisul (anhydrous ferric sulfate) has proved its superiority as a safe and dependable coagulant in boiler feed water because of its extremely adsorptive floc and its effectiveness under varying conditions of water temperature, alkalinity and pH.

Write for a copy of the *new* Ferrisul booklet, giving complete information on the use of Ferrisul for treatment of water, sewage and industrial wastes. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

FERRISUL
For
Boiler Water Treatment

MONSANTO
CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

RPM DELO keeps CHICAGO PNEUMATICS "exceptionally clean!"

When hundreds of hours of full-load engine tests prove to Chicago Pneumatic Tool Company that RPM DELO keeps its Diesels "exceptionally clean"—you, too, can bank on these four facts:

1—RPM DELO LUBRICATED engines work better—deliver top power!

2—RPM DELO LUBRICATED engines will last longer!

3—RPM DELO LUBRICATED engines will cut maintenance costs!

4—RPM DELO LUBRICATED engines will spend less time laid up for overhauls—more time on the job making money!

Chicago Pneumatic's findings back up the exhaustive lubricating oil tests of leading Diesel manufacturers. RPM DELO reduces carbon formations—eliminates bearing corrosion—ends ring sticking—keeps pistons and rings unusually free of lacquer—stops sludge trouble absolutely.

But prove all these clean-engine advantages in your own Diesels—regardless of make or size. Watch RPM DELO *down* costs, *up* profits for you!

RPM
REG. TRADE-MARK
DIESEL ENGINE LUBRICATING OIL

Order from Your Nearest Distributor as Listed Below:

IN THE UNITED STATES

RPM DELO:
The California Company (Montana only)
Humble Oil & Refining Company
Standard Oil Company (Indiana)
Standard Oil Company of Nebraska
Standard Oil Company of California
Standard Oil Company of Texas
Utah Oil Refining Company

Diol RPM DELO:
The Carter Oil Company, Tulsa, Oklahoma
Colonial Beacon Oil Company
Standard Oil Company of Louisiana
Standard Oil Company of New Jersey
Standard Oil Company of Pennsylvania

Kyso RPM DELO:
Standard Oil Company (Inc. in Kentucky)

Signal RPM DELO:
Signal Oil Company

Sohio RPM DELO:
The Standard Oil Company (Ohio)

IN CANADA & NEWFOUNDLAND

Imperial RPM DELO:
Imperial Oil Limited

IN BRITISH COLUMBIA & ALBERTA

RPM DELO:
Standard Oil Company of British Columbia Limited

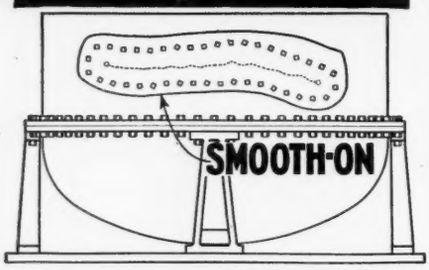
THROUGHOUT THE WORLD

RPM DELO is available through distributors in more than 100 countries.

Unequaled for every Diesel

STANDARD OIL COMPANY OF CALIFORNIA

Emergency Repairs



Cracked Evaporator Shell repaired with Smooth-On

Emergency and routine repairs to seal cracks and stop leaks in equipment under pressure, reinforce corrosion-weakened or punctured metal, and tighten loose parts, can be made by Smooth-On No. 1 with surprisingly little effort, time and cost.

This many-purpose iron cement is applied without heat or special tools, and forms a permanent seal which is proof against pressure and temperature variation, vibration, and the corrosive action of most chemicals. The cost is negligible; and savings may amount to hundreds of dollars, because the use of Smooth-On frequently avoids replacement of expensive parts, disassembling and reassembling.

Buy Smooth-On in 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house or if necessary, from us. For your protection, insist on Smooth-On—used by engineers since 1895.

FREE

The Smooth-On Handbook—40 pages with 170 diagrams and concise, easily followed instructions for practical equipment repairs, based on the experiences of thousands of engineers. Send the coupon for your copy.

SMOOTH-ON MFG. CO., Dept. 30,
570 Communipaw Ave., Jersey City, N. J.

Please send SMOOTH-ON HANDBOOK.

Name .....

Address .....

.....

7-40

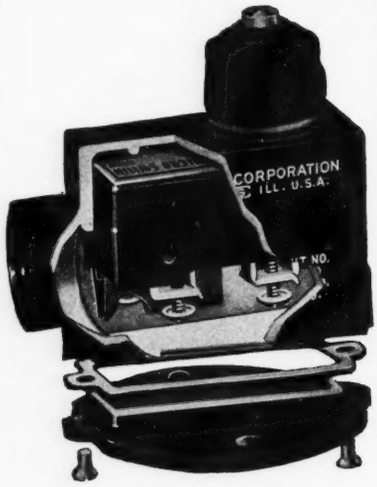
Do it with
SMOOTH-ON

ing compound is required to withstand hydrostatic pressure tests up to 450 lb. All refacers can be sharpened when dull.

Carlan Tool Co, 720 Edgar Road, Elizabeth, N. J.

Limit Switch

SOLVING the problem of how to seal a moving part from corrosive gases or liquids, engineers of company used Neoprene diaphragm as part of limit switch. Switch had to be sealed completely, so same composition was used as a gasket



between parts. Switch shown has plunger extending from top. Seal, in form of a cap, has hole through which plunger passes, remaining boot insuring positive seal. Flexibility of boot is said to enable it to follow plunger motion without interfering with its action.

Micro Switch Corp, Freeport, Ill.

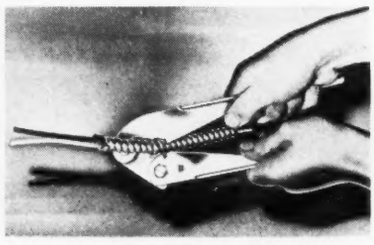
Exhaust Silencer

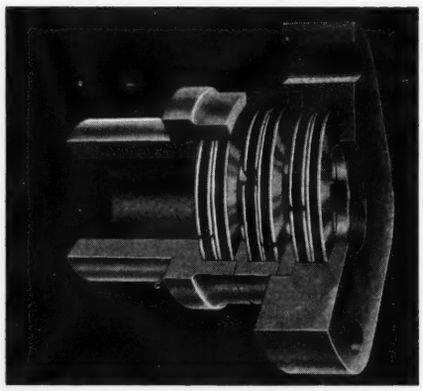
UNIVERSAL models follow principle preventing creation of sound waves and pulsation waves as opposed to silencing them after they are created. Built for silencing exhausts of 2- and 4-cycle internal combustion engines. Said to be adaptable to business buildings, etc, where noise cannot be tolerated.

Maxim Silencer Co, Hartford, Conn.

Armor Cutter

BX ARMOR CUTTER is pocket-size tool, with jaws formed to take BX cable of any make, 2- or 3-wire No. 12 or 14. To use tool, it is only necessary to open jaws, insert BX and snip. Cuts quickly and





France Metal Packing, Type No. 210, has three pairs of wearing rings and is suitable for pressures up to 150 lbs. Chiefly used on small rods and valve stems. It is outstanding for its economical and efficient performance on Corliss valve stems.

France Packing SAVES MONEY

Experience acquired for nearly half a century in selecting metals and designs for France Metal Packing has provided maximum sealing efficiency with minimum expense in all types of engines, pumps and compressors, operating under any condition of speed, pressure or temperature. This experience has imparted long life as well as efficient operation—we have records of France Metal Packings that are still giving satisfactory service after *thirty-five years of constant use.* For downright packing economy, insist on France Metal Packing.

Another important feature is *simplicity of installation.* It is only necessary to see that the rings are installed as lettered to correspond with similar letters on the case. As simple as A-B-C.

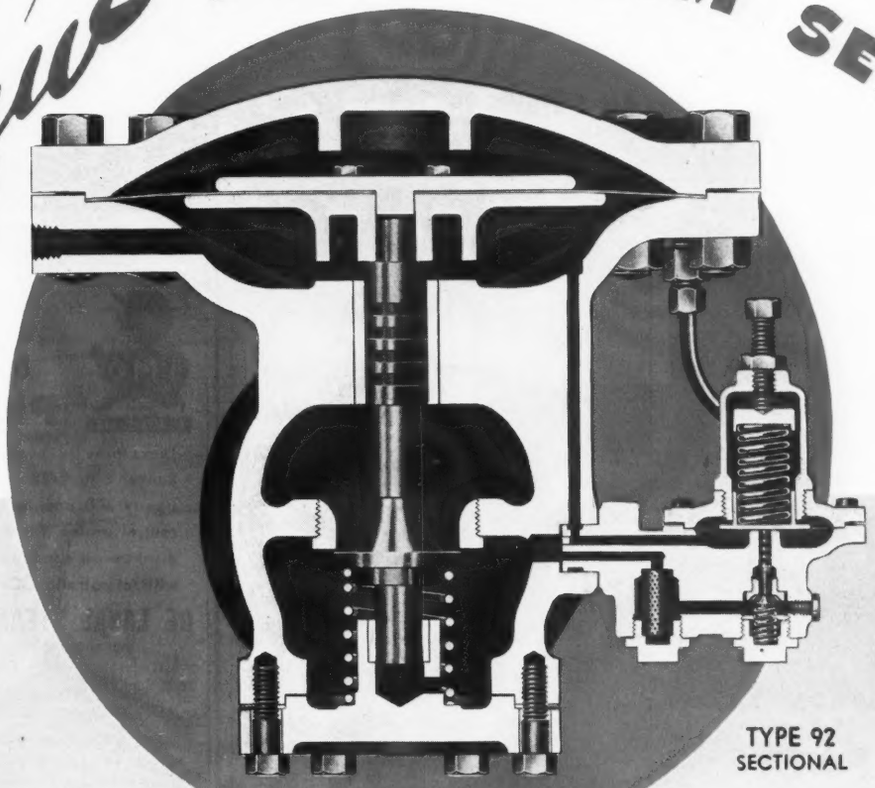
There is a qualified and experienced representative close at hand. Replacements or renewals can be obtained by furnishing the number stamped on the case and the rod diameter.

The new, profusely illustrated France Catalog M-7 is now available. Write for a copy and learn how to raise engine efficiency, reduce packing trouble and save money!

THE FRANCE PACKING COMPANY
Tacony, Philadelphia, Penna.
Branch Offices in Principal Cities

Original
FRANCE
METAL PACKING

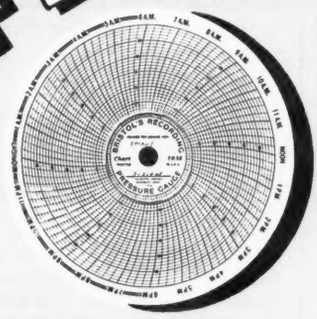
New FOR STEAM SERVICE



TYPE 92
SECTIONAL

this FISHER

PILOT OPERATED PRESSURE REDUCING VALVE



GUARANTEES EXTREME ACCURACY OF CONTROL — Chart at left shows how a new 4" Type 92 holds reduced pressure accurately at 4 lbs. while inlet pressure runs 80 - 100 lbs. Chart taken from steam make-up heating service installation at Iowa State College, Ames, Iowa. Here, this Type 92 opens and closes about 4 times per day. Maximum load 10,000 lbs. per hour.

SMOOTH, QUIET OPERATION — Type 92 does not "hunt" or pulsate — but throttles pressure smoothly.

HIGH TENSILE IRON BODIES of unusually large capacity. Ribbed construction imparts extra strength to bodies and diaphragm casings.

FOR HIGH and LOW PRESSURE SERVICES — two pilots are available and these are interchangeable on all sizes of Type 92 Valves. Reduced pressure setting of Pilots easily adjusted within limits of the pilot control spring — which, in turn, may be readily changed to obtain various pressure ranges.

REMOVABLE PILOT STRAINER — separate from valve body. Easy to clean. All Type 92 parts readily accessible for inspection.

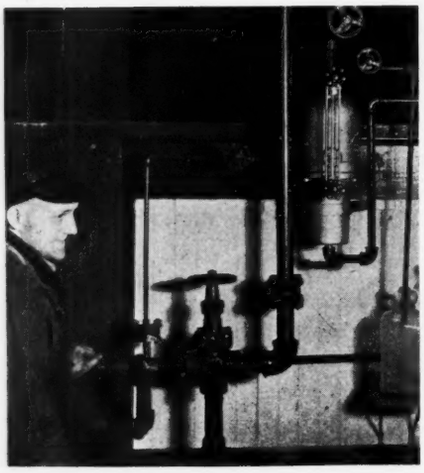
EXTREMELY COMPACT — ideal for installation in lines where space is limited.

10 SIZES — from ½" to 6". Globe bodies only. For reduced pressures from 1 to 200 lbs.

WRITE TODAY for FREE Bulletin C-1 containing complete data on performance and capacities. Also dimensions and prices. Don't delay!

FISHER GOVERNOR COMPANY 409 Fisher Bldg., Marshalltown, Iowa

ARMSTRONG PURGERS *for* Refrigeration Systems



QUICK FACTS:

1. **CUTS POWER COSTS—Records show reductions in head pressure of as much as 45 lbs. and power savings as high as 22% where purgers have been installed to remove air and other non-condensible gases from refrigeration systems.**

2. **MINIMUM LOSS OF REFRIGERANT GAS—Condensation within Purger takes place at high side pressure, but at low side temperature.**

3. **AUTOMATIC—Ordinarily, no manual attention is required after the Purger is installed. When the system needs purging, the Purger goes to work!**

4. **INCREASES COMPRESSOR CAPACITY—Every 4 lbs. reduction in head pressure increases compressor capacity approximately 1%!**

5. **LARGE CAPACITY—The No. 243 Purger shown here has been used successfully on systems ranging in size from 12 tons up to 1200 tons capacity.**

6. **LOW COST—The unit lists at only $100.00. Savings quickly pay for it!**

7. **DEPENDABLE—The Armstrong Purger is time tested. It is simple, rugged. All working parts are made of stainless steel.**

8. **FLOAT SERVICE, TOO—The Purger can be used as combination purger and high side float where desired!**

We will be glad to send you complete information. Write ARMSTRONG MACHINE WORKS, 812 Maple Street, Three Rivers, Michigan.

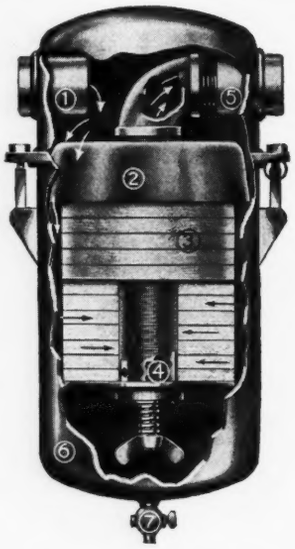
ASK FOR A COPY OF THIS NEW BULLETIN

cleanly, according to maker, without any injury to wire. Hardened steel cutting blade is removable for sharpening.

Ideal Commutator Dresser Co, 1025 Park Ave, Sycamore, Ill.

Air Filter

MODEL AAPHS air filter is designed for complete removal of slightest traces of oil from compressed-air lines. Disks (3) said to possess large absorption area with good filtering efficiency. These disks are of Feltex and are carried on a tube composed of an inner liner of perforated metal covered with a fine bronze-wire-mesh



screen. This tube (4) helps to drain oil removed from the air to bottom of filter shell (6). Lower portion of filter shell is removable for inspection and cleaning by loosening swing bolts (8). Additional construction details are deflector cup (2), intake pipe (1), outlet (5), and drain cock (7). Direction of air travel is indicated by arrows.

Staynew Filter Corp, Rochester, N. Y.

Refractory

THINSULITE is combination of refractory, insulation, and suspended tile principle. Material is suitable for boiler walls, waterwall backing, etc. Advantages claimed are low costs for materials, light weight, low heat loss, permanent heat and air tight construction, and low maintenance cost.

M H Detrick Co, 140 S Dearborn St, Chicago, Ill.

Fire Extinguishers

BUFFALO CTC 1- and 2-gallon extinguishers have heavy-drawn brass seamless shell and are pump-driven. Units have no outside valves to shut off and stream stops as soon as pumping stops. Both extinguishers have been tested by Underwriters Laboratories.

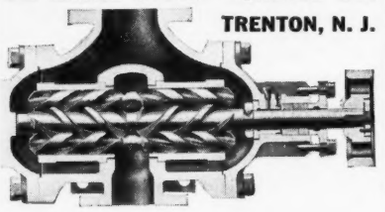
Buffalo Fire Appliance Corp, Buffalo, N. Y.

GOOD COMBUSTION *needs* STEADY PRESSURE

IMO means I MOVE OIL

These three De Laval-IMO's are delivering Bunker C to the burners at a continuous, steady 300 pounds pressure in a large central station. The De Laval-IMO rotors displace oil continuously and uniformly without pulsation. Catalog I-61 tells why.

DE LAVAL STEAM TURBINE CO.
TRENTON, N. J.



"STANDCO" PILLOW BLOCKS

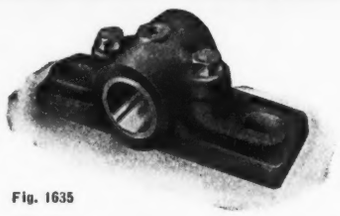


Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth. It can be depended on for long, trouble-free service.

Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.

Boston, Detroit, Indianapolis — Box 577 — Chicago, St. Louis, San Francisco

You Learn How to Save When You Learn the Facts

These Inkless Recorders Give You the Facts ACCURATELY—QUICKLY—EASILY

Here are some of the reasons why you'll like to use the new G-E inkless recorders

Type CF-1 recorders are available as voltmeters, ammeters, and current-measuring sets

NO INKWELL TO FILL — NO PEN TO START

They're ready to go at a moment's notice—no messy inkwells to clean and fill—no pens to start or get clogged up. And there's no ink to spill or blur the record—no chance for "painted" charts when the load fluctuates rapidly.

PORTABLE—WEIGHS ONLY 12 POUNDS

These economical instruments weigh only half as much as conventional recorders. They're easy to carry and easy to mount on walls or poles.

EASY TO MAINTAIN

They will operate successfully for as long as 30 days without attention. At the end of a month all you have to do is install a new chart and reverse the marking ribbon.

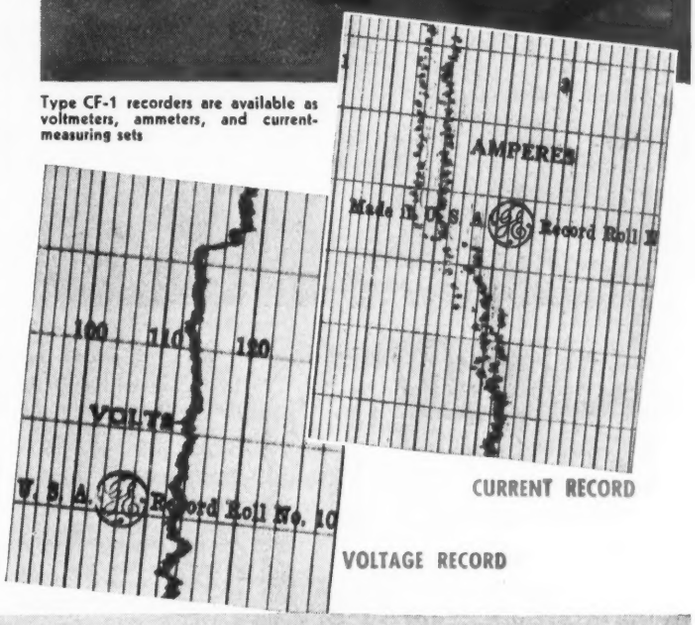
AN EASY-TO-USE CURRENT-MEASURING SET

The ammeters are available for use as current-measuring sets, including a convenient split-core current transformer. To record load conditions on your electrically operated equipment, you simply hook the transformer around the line. There's no need to cut into the conductors or interrupt work.

RECORDS ARE DISTINCT—EASY TO READ

These two photographs show the legibility of records obtained with G-E inkless recorders. Note that the current record clearly indicates the maximum and minimum current values on the fluctuating load. There's no smearing or painting of the chart.

Call your nearest G-E office for further information, or write for Bulletin GEA-3187. General Electric, Schenectady, N. Y.



CURRENT RECORD

VOLTAGE RECORD

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

602-6

ADVERTISING PAGES REMOVED

Power Plants Earn More Money with this New Way to Clean Tubes.

★ **FASTER** — Rapid - action 'trigger' on motor eliminates signalling delays. Puts the boiler back on the line hours sooner.

★ **CHEAPER** — One - man operation eliminates helper and reduces cost of compressor operation.

★ **BETTER** — Greater cleaning power of new design motor removes scale far more quickly and effectively.

We've been selling tube cleaners to Power Plants long enough to know better than to make claims that we can't make good. Here are facts which you can verify. The new rapid-action Roto Tube Cleaners are removing scale in leading power plants up to 30% faster, and in some cases up to 66% faster, than old type cleaners.

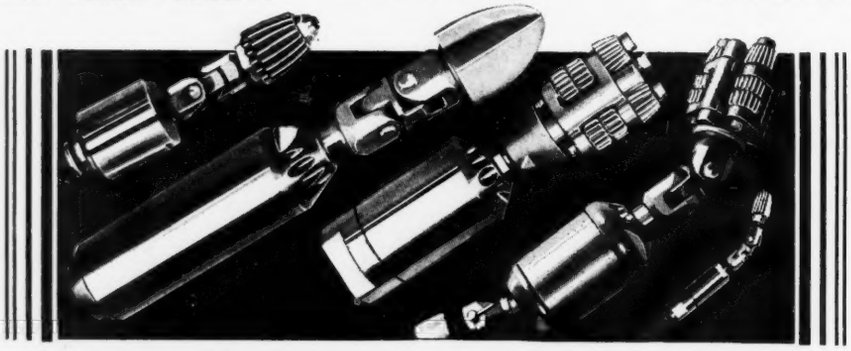
Time and money saving features found exclusively on Roto cleaners now make it profitable to clean tubes more frequently and thereby keep boilers working at higher levels of efficiency. It will pay you to let us prove it in your plant.

Only **ROTO** Can Offer You ALL These Features

SEE OUR ADV. IN SWEET'S CATALOG

The ROTO Company

145 SUSSEX AVENUE NEWARK, N. J.



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for technical and business men

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New Bulletins

BOILERS AND ACCESSORIES

1 BOILERS—Babcock & Wilcox Co, 85 Liberty St, New York, N. Y. Bulletin No. G-28 describes Design 32 cross-drum, straight-tube, sectional header unit for pressures of 250 lb or less, with heating surface from 1000 to 6000 sq ft.

2 SPUN HEADS—Lukens Steel Co, Coatesville, Pa. Board-bound, 132-page catalog covers various types of spun heads for boilers and other pressure vessels. Numerous code specifications included, and other engineering data given.

3 BOILER ACCESSORIES—Steel Improvement & Forge Co, Cleveland, Ohio. "Boiler and Tank Accessories" presents complete line of Diamond-S accessories for boilers and tanks. Includes descriptions of welding fittings, forged flanges, manhole covers, etc.

4 STOKERS—Detroit Stoker Co, General Motors Bldg, Detroit, Mich. 24-page bulletin describes Detroit Unistoker, showing sectional views and typical application in several plants. Photographs show stokers being assembled before shipment.

5 REFRACTORIES—Atlas Lumnite Cement Co, Chrysler Bldg, New York, N. Y. 24-page bulletin "Refractory Concrete" describes refractory concrete made with "Lumnite". Special uses for this concrete, together with those for insulating and heat-resisting cements, presented.

6 REFRACTORIES—General Refractories Co, Philadelphia, Pa. 4-page bulletin No. 209 covers Sillimanite brick, cement and plastic refractories, and shows results of tests made with three different types of cements.

7 FIREBRICK—A P Green Firebrick Co, Mexico, Mo. 4-page bulletin describes Empire firebrick, giving photos showing typical applications. Types of brick available also given.

8 STOKERS—Canton Stoker Corp, 741 Andrew Pl, Canton, Ohio. 8-page bulletin No 203 describes Vulcan type stoker, showing assembly, cross-sectional views, material specifications and specification outline.

ELECTRICAL EQUIPMENT

9 THERMOCOUPLES—Wheelco Instruments Co, 1923 S Halstead St, Chicago, Ill. 16-page booklet covers products made by company, including thermocouples, thermocouple wire, lead wire, insulators, protecting tubes, etc.

10 RESISTORS—Hardwick-Hindle, Inc, Newark, N. J. 12-page catalog No. 40 lists, describes and illustrates line of resistors and rheostats, and includes specifications and prices for each.

11 CIRCUIT BREAKER—I-T-E Circuit Breaker Co, 19th & Hamilton Sts, Philadelphia, Pa. 35-page catalog No. 5001 describes and illustrates uses of Type ET circuit breaker, used mainly for load centers, power panels, etc.

AIR CONDITIONING & REFRIGERATION

12 GAS PURGER—Armstrong Machine Works, 812 Maple St, Three Rivers, Mich. 8-page bulletin "New Ways to Cut Refrigeration Costs" describes Armstrong purger, giving instruction on operation, installation recommendations, and users' testimonials. Gives brief description of Armstrong "High-Side" Float.

13 AIR FILTERS—Air-Maze Corp, 5200 Harvard Ave, Cleveland, Ohio. 4-page folder, No. M-340, presents construction features, efficiency, pressure drop, dust capacity, etc, of Multimaze air filters.

MATERIALS HANDLING

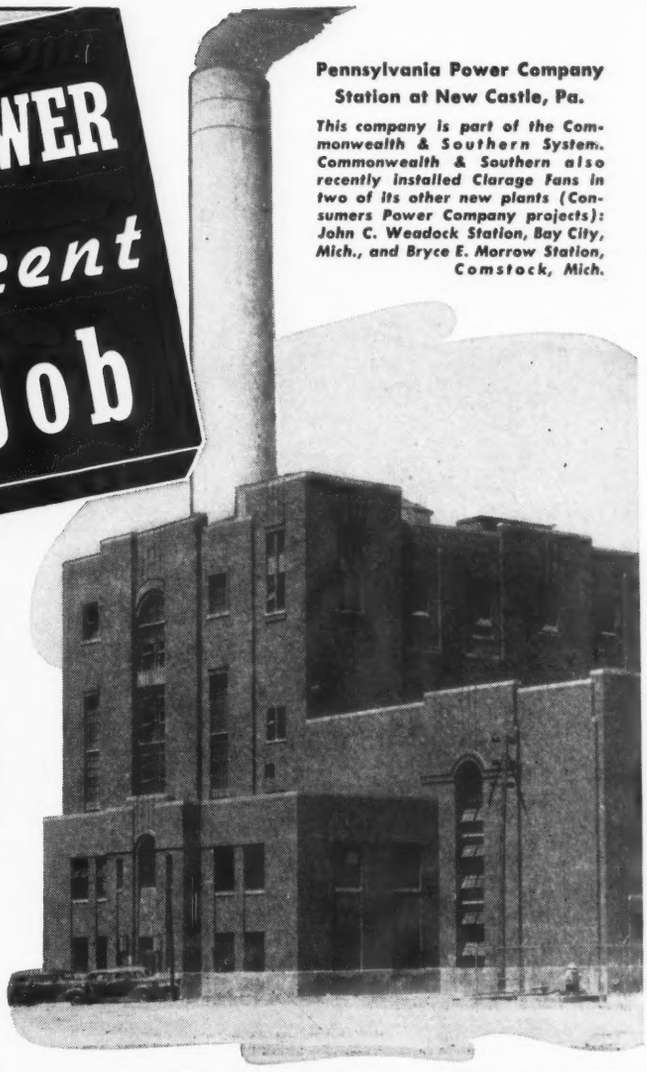
14 MATERIALS HANDLING—Lewis-Shepard Sales Corp, Watertown, Mass. Catalog No. 21 commemorates 25th Anniversary of company, and covers over 175 of items made by company. Catalog has half inch visible tab for filing.

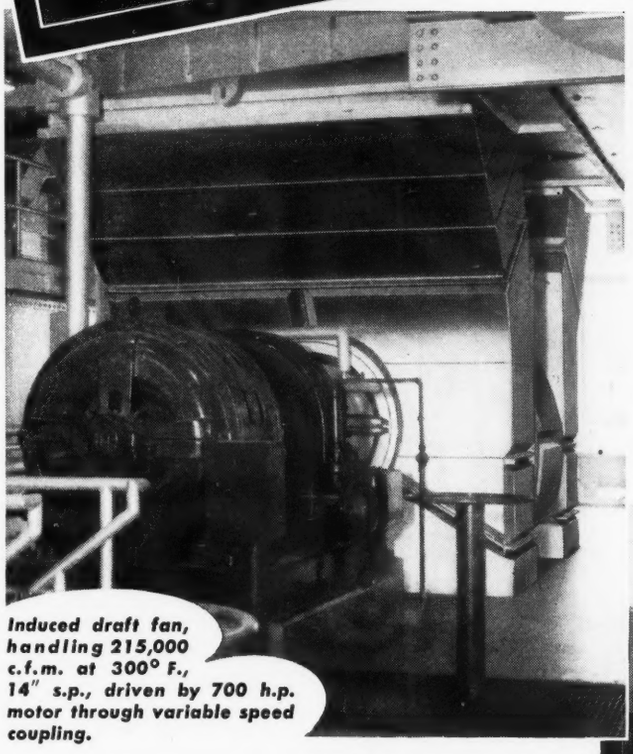
15 MATERIALS HANDLING—Link-Belt Co, 307 N Michigan Ave, Chicago, Ill. 48-page book No. 1700 pictures numerous typical applications of Link-

PENNSYLVANIA POWER *Another Recent* CLARAGE Job

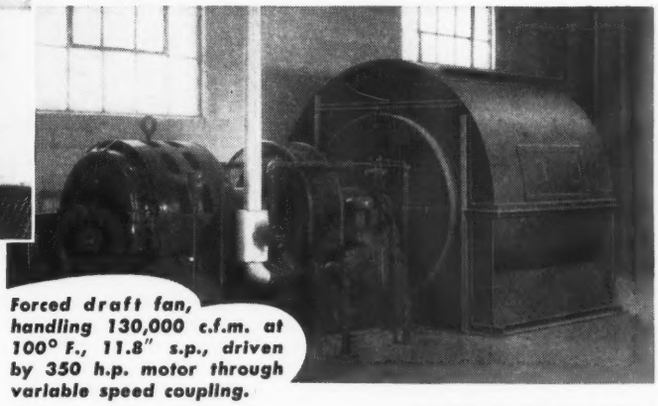
Pennsylvania Power Company Station at New Castle, Pa.

This company is part of the Commonwealth & Southern System. Commonwealth & Southern also recently installed Clarage Fans in two of its other new plants (Consumers Power Company projects): John C. Weadock Station, Bay City, Mich., and Bryce E. Morrow Station, Comstock, Mich.





Induced draft fan, handling 215,000 c.f.m. at 300° F., 14" s.p., driven by 700 h.p. motor through variable speed coupling.



Forced draft fan, handling 130,000 c.f.m. at 100° F., 11.8" s.p., driven by 350 h.p. motor through variable speed coupling.

In this giant new 35,000 Kw station, Clarage Fans handle both forced and induced draft. These fans are designed for modern high-speed operation — ideal for direct motor drive. They are built like battleships — capable of long-time dependable service when giving all they've got. ***Over 2,000 power plants now Clarage equipped!***

WRITE FOR NEW BULLETIN—Just Off Press

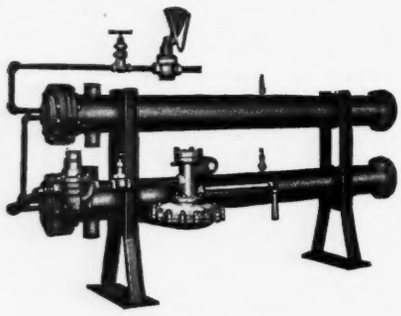
This Bulletin describes the latest Clarage mechanical draft development, Type RT Fans — many cost-saving features: new streamlined wheels, new water-cooled bearings, etc. Sizes to meet every service condition. See why so many power plant authorities consider Clarage "Ace High" in the mechanical draft field.

COMPLETE AIR CONDITIONING • COOLING • VENTILATION • FACTORY HEATING • MECHANICAL DRAFT • FANS and BLOWERS for INDUSTRIAL NEEDS

CLARAGE FAN COMPANY–KALAMAZOO, MICH.
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

HENSZEY

Continuous Blowdown



INSURES

- CLEAN BOILERS
- CLEAN WATER
- CLEAN STEAM

CLEAN BOILERS mean:

No boiler scale • Less labor cleaning boilers • Lower fuel bill • Greater boiler capacity • Better circulation • Increased life for boilers • No tube burns • Longer period between shut downs.

CLEAN WATER means:

No priming • No foaming • No caustic embrittlement • Lower fuel bills • Steady water level • Greater boiler capacity • No clogging of dry pipe • Much less corrosion.

CLEAN STEAM means:

Packings last longer • Less cylinder oil consumption • Less wear on rods and cylinders • Less turbine blade erosion • No coating of turbine nozzles and blades • No sticking of reducing valves, non-return valves, traps, etc. • More superheat • Cleaner condenser tubes • Less piston and valve leakage • Less steam consumption • No superheater burnouts.

THE HENSZEY SYSTEM HAS MAXIMUM HEAT RECOVERY OBTAINABLE BECAUSE

High Temperature Heat Exchanger returns heat directly to boiler feed water.

Low Temperature Heat Exchanger transfers the remaining heat to the cold make-up water.

Blowdown is automatically proportioned to make-up.

SEND FOR BULLETIN

HENSZEY COMPANY

Dept. D 7 **Watertown, Wis.**

HENSZEY

50 FLEXIBLE METAL HOSE—Chicago Metal Hose Corp, Maywood, Ill. 36-page catalog G-31 covers Rex-Weld and Rex-tube flexible metal hose. Also includes descriptions of stainless-steel bellows, Rex bellows and diesel exhaust hose.

51 WEIGHTS—Revere Copper & Brass, Inc, 230 Park Ave, New York, N. Y. Of interest solely to engineers, draftsmen, estimators and designers, catalog lists weights and data for all types of copper, brass and bronze products. Conversion factors, weight formulas, and comparison of wire gages included.

52 METALS & ALLOYS—International Nickel Co, Inc. 67 Wall St, New York, N. Y. 16-page, pocket-size booklet contains uses and properties of nickel and high nickel alloys, including three pages on mechanical, chemical and physical properties.

53 PAINTS—The Skybryte Co, 3125 Perkins Ave, Cleveland, Ohio. 16-page Catalog describes various paints made by company. Includes acid-resisting, alkali-resisting, general purpose aluminum, heat-resisting aluminum, and various other paint products.

54 CRUSHERS—American Pulverizer Co, 1249 Macklind Ave, St. Louis, Mo. 8-page bulletin describes "rolling Ring" and swing hammer crushers, together with grinders and shredders for the laboratory. Line drawings presented.

55 HEAT-CONTROL SYSTEM—Armstrong Heat Control Corp, 1307 N E Eleventh Ave, Portland, Ore. 8-page bulletin describes Armstrong Heat Control system, tells what it is and what it does. Shows numerous installations, giving approximate savings effected by use of system.

56 CONCRETE—Flexrock Co, 23rd & Manning St, Philadelphia, Pa. 4-page folder illustrates applications and describes Concretdense, compound used for resurfacing floors and patching holes in concrete floors. Method of mixing and application included.

57 LUBRICATORS—C A Norgren Co, Inc, 226 Santa Fé Drive, Denver, Colo. 20-page catalog No. 300 pictures and describes Norgren pneumatic products, including sight-feed automatic air line lubricator, automatic lubricators, filters, regulating and reducing valves, relief and blow valves, couplings, hose stems, and hydraulic hose assemblies.

58 FLOOR DYE—Flexrock Co., 23rd & Manning St, Philadelphia, Pa. 4-page bulletin describes Colorflex, resin-base floor dye. Instructions concerning application given, and features of coating are presented. Details of trial offer also listed.

59 SAFETY SUPPLIES—Boyer-Campbell Co, 6540 Antoine, Detroit, Mich. Price list No. 4 is part of catalog 40, covering all types of safety supplies and equipment. Includes prices on face shields, welders' goggles, respirators, first aid cabinets and kits, and safety shoes, etc.

60 FUSES—Trico Fuse Mfg Co, Milwaukee, Wis. 4-page bulletin concerns Trico unbreakable wick-feed oilers. Types LA, LB, LC, LD included. Brief descriptions of each type presented, together with photo of oiler, and table listing dimensions. General information on all types of oilers included.

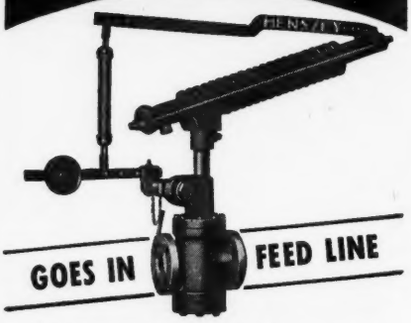
61 COATINGS—Dampney Co of America, Hyde Park, Boston, Mass. 8-page booklet No. 1290 describes Dampney protective coatings for preservation of metals, and equipment for applying. Includes brief descriptions of Apexior No. 1 and 3, and Styles E and F Powercoater for use in applying coatings. Complete instructions on how to apply coatings, as well as how to order same are given.

62 RUST-PROOFER—American Chemical Paint Co, Ambler, Pa. 4-page booklet gives method of preparation of rust-proofer, together with application instructions. Also presents brief notes about other company products, including Rodine, Clorodine, Cuprodine, Elastic primer, Lithoform, Deoylyte, Deoxidine, and Kemick.

63 NUTS—Elastic Stop Nut Corp, 2330 Vauxhall Rd, Union, N. J. 4-page illustrated folder tells how elastic stop nuts work, and cartoon illustrations give advantages and specifications. Typical fastening problems solved with stop nuts pictured on last page.

HENSZEY

BOILER FEED REGULATORS



The Henszey Boiler Feed Regulator is a self-contained unit needing no additional structural supports. It is as easy to install as a simple gate or globe valve.

Working on the principle of thermal expansion in a metallic tube, it accurately controls the boiler water level at all loads —from the lightest to the heaviest. It offers an Everdur expansion tube with copper radiators for quick action, outboard ball bearings and grease packed stuffing box in all sizes and for all pressures. You get more for your money!

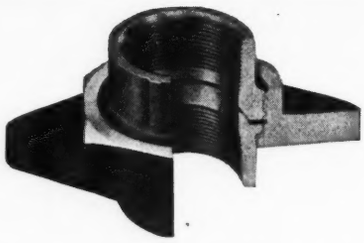
For dimensions—capacities—details. Send for latest bulletin.

HENSZEY COMPANY

Dept. D 7 **Watertown, Wis.**

CATAWISSA

LUG NUT UNIONS



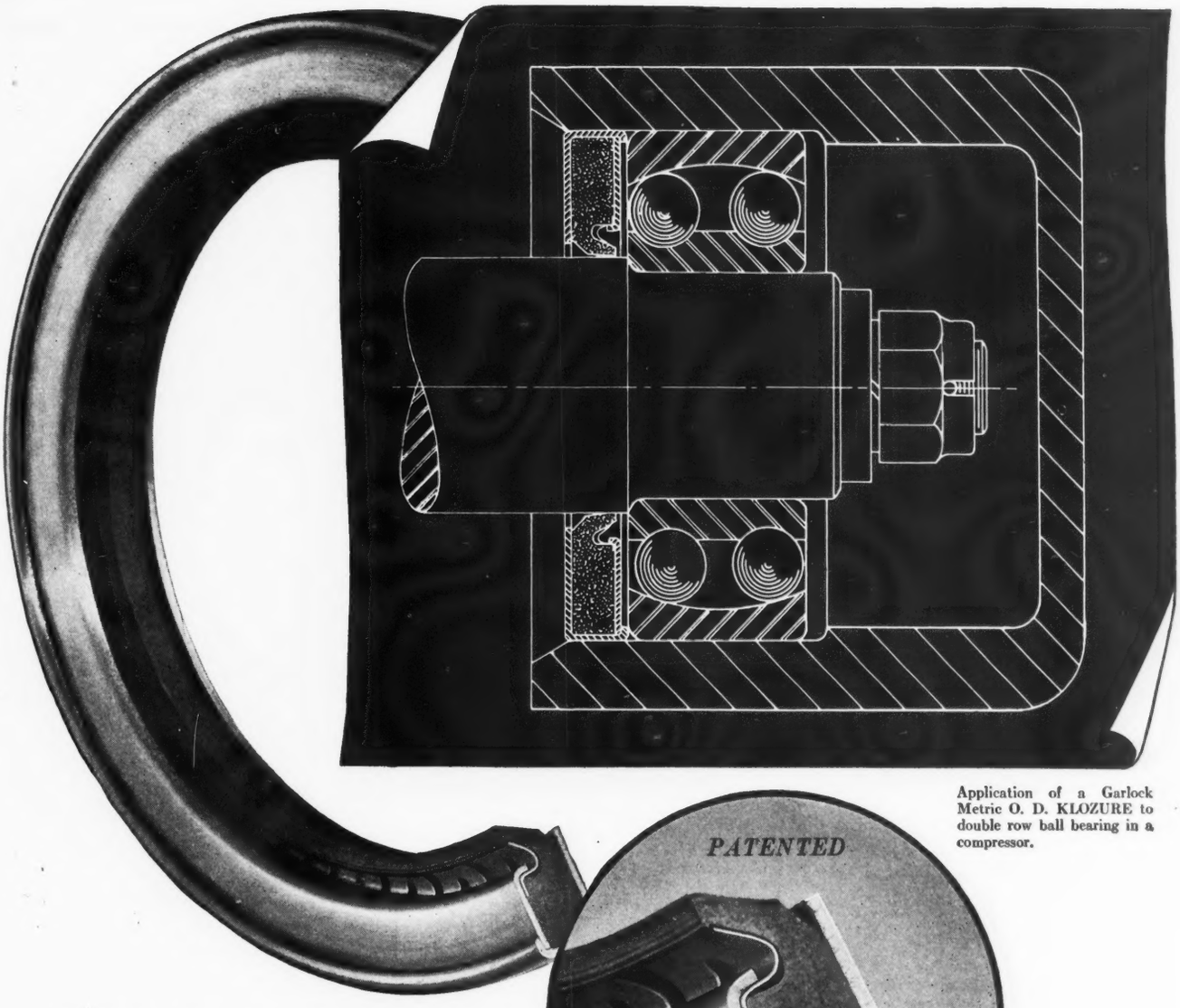
Forged from High-Grade Steel Bars . . . Can be applied with either Hammer or Wrench . . . Always presents flat striking surface . . . Shape of Lug prevents distortion . . . Heavy, Coarse Acme Threads for quick opening and closing—Non-Freezing. . . .

The Union Seat is a ball on the male end to a 55° angle on the female end . . . Hand Ground. . . .

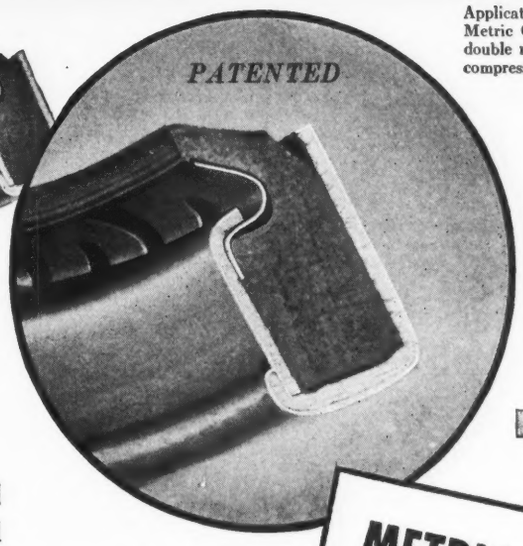
Indispensable on Steam Lines where using a wrench would be hazardous due to high temperature and pressure and on buried lines and other applications where a half turn of the Union Nut with a wrench would be difficult. *Write us today for sizes and prices!*

THE CENTRAL FORGING CO.

CATAWISSA, PENNA.



Application of a Garlock Metric O. D. KLOZURE to double row ball bearing in a compressor.



KLOZURE

-A Superior Oil Seal

The Garlock KLOZURE keeps dust, dirt and water out of the bearing . . . keeps oil and grease in. The KLOZURE sealing ring is made of an *exclusive* Garlock compound which resists oil and water at high or low temperatures. It is dense, grainless, tough and resilient . . . does not become soft and flabby in service. Complete range of sizes. Write for catalog!

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

METRIC O.D.'S

To provide an oil seal that fits into the same housing bore that receives ball and roller bearings made to Metric O.D.'s, Garlock now manufactures a line of KLOZURES with Metric O.D.'s. The usage of Metric O.D. KLOZURES frequently results in a considerable saving in machining and tooling costs. Also cuts down installation time. Write for further details.

GARLOCK

Don't Let Your

PUMPING PROBLEMS

Throw You . . . .

The minute you find yourself up against a puzzling pumping problem, it's time to get in touch with Viking. Just write in detail the type of pump you need, the amount of room you can spare for installation, the required drive arrangement. That's all there is to it . . . you leave the rest to Viking's engineering superiority, Viking's experience, Viking's complete knowledge of power pumping problems and needs. Write that letter today . . . we'll mark it for "special attention".

Look For This Trade Mark — The Sign Of A Genuine Viking

VIKING PUMP CO.

CEDAR FALLS, IOWA

Engineers' Books

Boilers

BOILER OPERATOR'S GUIDE (1940). *By Harry M Spring Jr. Published by McGraw-Hill Book Co., 330 W 42nd St, New York, N. Y. 353 pages, 6x9 in., 242 charts and illustrations, 310 questions and answers, cloth binding. Price $3.00.*

POWER readers are familiar with Harry Spring's clear-cut and authoritative writings on boiler-plant operation and maintenance. In this new book, he has covered the entire field, producing a valuable practical handbook for all concerned with boilers and accessories, but of particular usefulness to the operating engineer. For the benefit of younger engineers preparing for license examinations and for all engineers desirous of increasing their knowledge, Mr Spring has included 310 questions similar to those asked in examinations for stationary-engineering or boiler-inspection licenses. These questions, and their answers, are grouped according to subject matter and appear at the end of each chapter.

Starting with a simple presentation of stress considerations and boiler design, Mr Spring proceeds to describe the chief construction features and operating characteristics of the important types of fire-tube and water-tube boilers. An extensive chapter on boiler appliances and auxiliaries covers all the equipment needed for safe and efficient boiler operation. Operating engineers will find particular value in chapters on boiler-plant management and problems of boiler operation; these cover every phase of operation, inspection, maintenance and testing. The five appendices include a glossary of boiler terms, data on materials and boiler scale, instructions for making riveted patches, and a list of boiler safety rules.

Mr. Spring's book fills a real need for an up-to-date and practical work on boiler plants; it can be highly recommended.

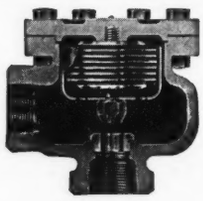
Piping

FLEX-ANAL CHARTS (1940). *By E A Wert and S Smith, Detroit Edison Co. Published by Blaw-Knox Co, Power Piping Division, Pittsburgh, Pa. 80 pages, 8½ x 11 in., 36 analysis chart plates each containing several illustrations. Price $3.00.*

A treatise for the experienced pipe designer for analyzing the flexibility of piping systems by use of charts. Use of these graphical methods reduces calculations from many days to a few hours. They permit a quick determination of proper design of high-temperature steam piping from a flexibility standpoint before spending time and money in drafting-room effort.

They are also accurate for final calculations and apply to all usual piping materials including carbon-moly. Determination of forces at anchor points, stresses in the pipe wall, bending moments and change of shape are possible for various predetermined shapes of piping structures.

NICHOLSON



TYPE "C"

NON-FREEZING - HIGH CAPACITY INDUSTRIAL STEAM TRAPS

Cannot freeze (can be placed right out in the weather); is never water-logged; cannot air-bind; intermittent discharge; largest water and air discharging capacity of any trap on the market; same size valve is used on vacuum as at 200 lbs.; moderate in price. "Nicholson" Industrial Trap Bulletin No. 439 on request. Sent on trial.

ALSO:—Nicholson Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON STREET
WILKES-BARRE PENNSYLVANIA, U.S.A.

Save Air—Save Dollars
WITH
ROCKWELL BLAST GATES

Threaded Butterfly Type

Wafer Butterfly Flanged Type

For Low Pressure Air

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Slide Type
Butterfly Type
Wafer Butterfly Type
Kwikleen Type

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Write for catalog No. 3760

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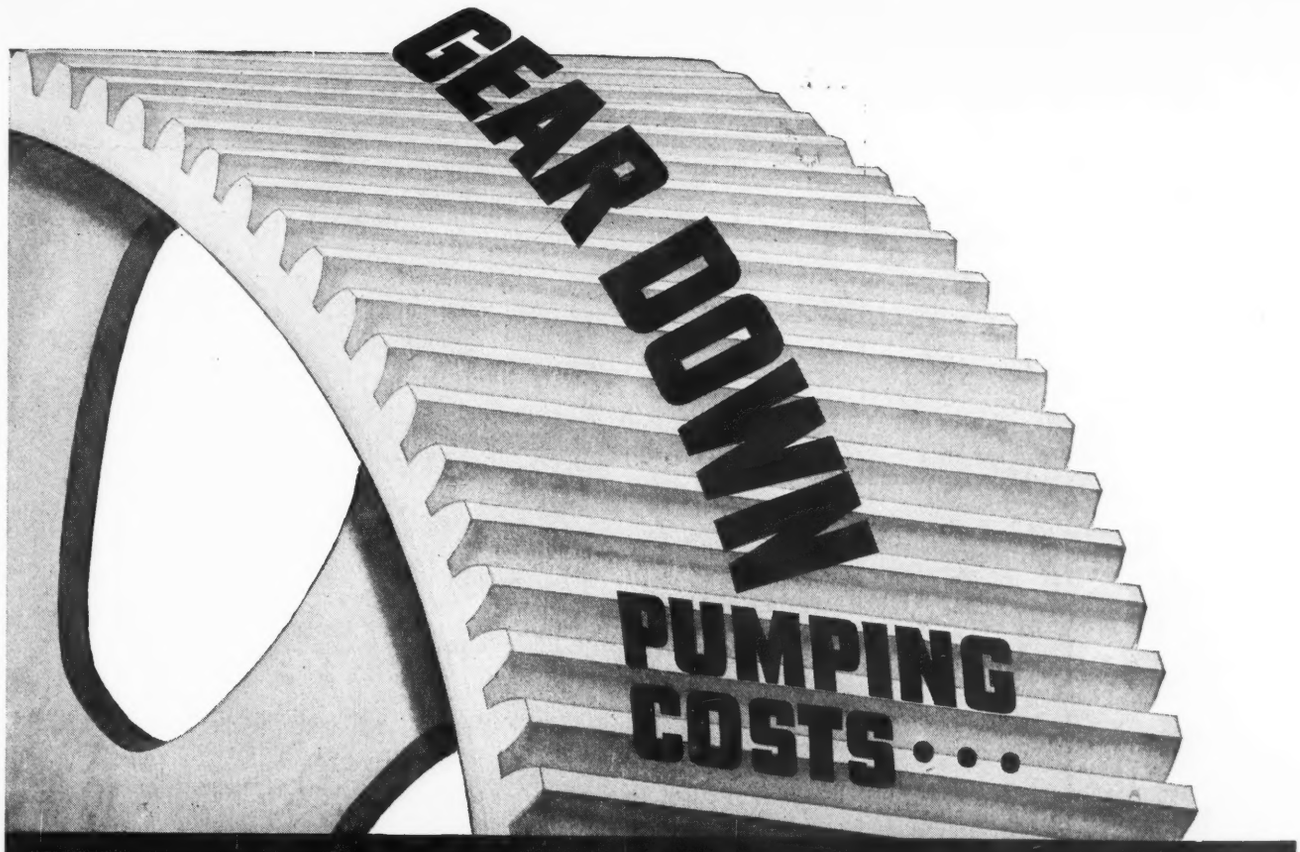
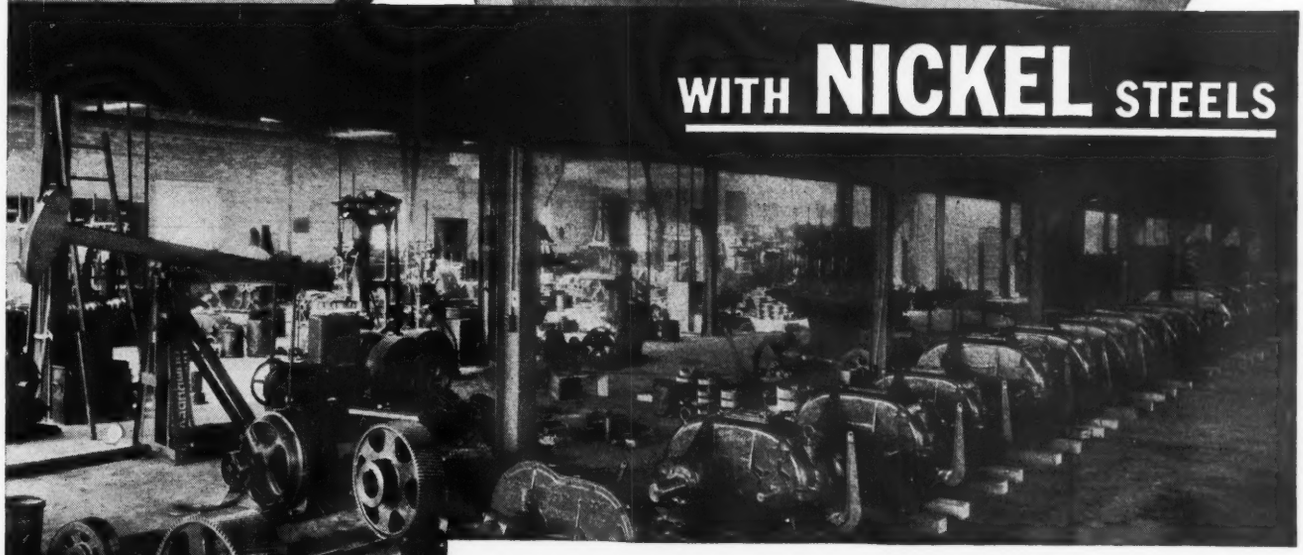
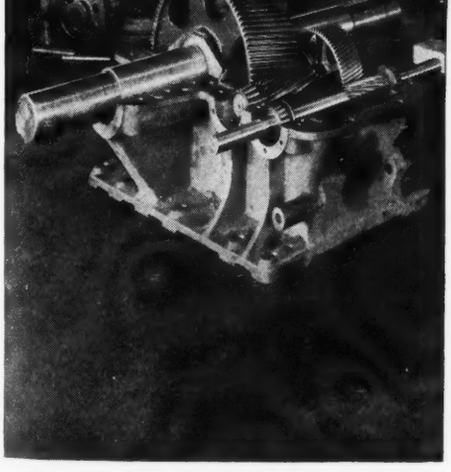
W. S. ROCKWELL COMPANY
50 CHURCH ST., NEW YORK



WITH NICKEL STEELS





Herringbone, or helical—geared single or double reducers for pump speeds of 9 to 40 r.p.m. are a specialty of the Foote Gear Works, Cicero, Illinois.

Losses from gear and pump failures are almost eliminated by use of strong, wear-resisting Nickel alloy steels.

Foote's long experience with highly stressed parts in oil field as well as other industrial reducer and gear applications, and trouble-free performance records of metals alloyed with Nickel, guided their engineers to specify heat treated Nickel molybdenum steel, SAE 4640, for pinions. Shafts, weighing up to 3,000 lbs. in larger units, are Nickel-chromium-molybdenum steel. Large gears are cast in a pearlitic Nickel-manganese steel, heat treated to 300 Brinell hardness.

Your consultation regarding uses of Nickel is invited.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Another OAKITE IDEA to help you save!

LOW-COST WAY TO DE-SCALE DIESELS

YOUR DIESEL ENGINE . . . does it overheat? Are lime scale and rust deposits impairing cooling efficiency? Then remove these insulating accumulations successfully . . . yet SAFELY . . . with fast-working Oakite Compound No. 32 NOW, before serious trouble develops.

Simply permit solution of this superior scale-dissolving material to soak for short time . . . then rinsing leaves passages clear and clean! Heat transfer efficiency is restored. Method is easy, too . . . no dismantling needed. And the LOW COST will please you!

Save Money . . . Save Time ON THESE JOBS, TOO!

On other maintenance jobs, too . . . stripping transformers, cleaning air filters, cleaning "lube" oil coolers, steam cleaning, etc., . . . Oakite materials can save time and money for you. Write for helpful, money-saving data on your cleaning problems. No obligation.

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE Certified cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Power Lines

(*Continued from page 126*)

and manufacturers of fuel-burning equipment carried the primary responsibility for selection of coal and proper equipment to burn it with little or no smoke.

Pennsylvania RR Foreman of Engines, H J Riddle, detailed a number of specific methods in use by the railroads to prevent smoke. A panel discussion of alternate methods of hand firing by D H Williams, J E Tobey, V G Leach, G G Ritchie and Stewart Orgain emphasized the fact that any coal can be burned smokelessly, even with hand firing, if the combustion chamber is correct and adequate and methodical care is taken in firing.

Application of brick arches, loosely packed fuel beds, sloping grates, greater care in processing coal and, above all, systematic inspection and repair work, he said, have reduced coal consumption as well as improved smoking characteristics.

Other technical sessions covered oil- and gas-burning equipment, mechanical firing of solid fuel, atmospheric corrosion, fly-ash problems and the use of overfire air.

Refrigerating Engineers Meet at Skytop, Pa.

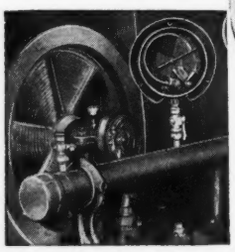
Air conditioning, compressor performance, and refrigeration applications held the attention of the American Society of Refrigerating Engineers, at their 27th Spring Meeting, June 9-11, at the Skytop Club, Skytop, Pa.

Emphasizing the importance of zoning to insure satisfactory operation of air-conditioning systems for office buildings and similar structures with multiple occupancy, Walter A Grant, Carrier Corp, analyzed the exposure factors and internal factors which affect air conditioning loads. He listed five basic methods of zoning (1) by separate heating or cooling equipment, which is most flexible and economical in operation but most expensive from the first-cost viewpoint; (2) by reheating or recooling, which is simple but wasteful; (3) by separate recirculating fans, which is flexible and not overly expensive but involves wasteful reheating when simultaneous heating and cooling is required in different zones; (4) by dual-duct systems which maintains substantially constant air volume and give flexibility but are apt to be expensive; (5) by volume dampers which, while cheap and low in operating cost, possesses limitations since throttling volume may upset air distribution, may cause a temperature reduction of supply air, may impair ventilation, and fails to permit simultaneous heating and cooling.

Pointing out that the degree of zoning installed is an economic question, Mr Grant stressed its value in producing satisfactory results for the occupants, which is the ultimate test of the economic worth of air conditioning.

Experiments to determine the effect of using suction refrigerant gas to cool the motor of a condensing unit showed that, contrary to expectations, the resulting superheating of the gas entering the com-

39,360 "PRESSURE JOLTS" PER DAY FOR 3 YEARS—AND STILL IN PERFECT CONDITION!



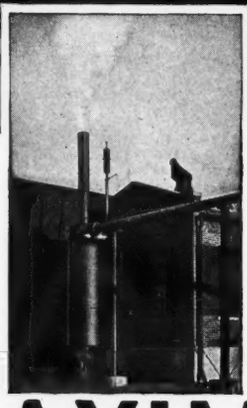
If your Gauges can take this — they can take anything!

Think it over. Packed into a comparatively short time is service more severe than your gauges must endure in an average lifetime, *and the LONERGAN Gauge shows no sign of its service age!* If that's the kind of gauge performance you're seeking—here it is—undeniably proved!

Catalog and name of nearest distributor on request.

Lonergan
GAUGES • VALVES • SPECIALTIES
J. E. LONERGAN COMPANY
RACE & SECOND STS. • PHILADELPHIA, PA.
300 Specialties for Power Plants • Since 1872

Silence STEAM EXHAUSTS



with MAXIM SILENCERS

The problem of silencing the exhaust from a Skinner Uniflow Steam Engine was quickly solved by the MAXIM MUI Silencer shown above.

In addition to this type of Silencer, Maxim also makes Silencers for high pressure waste steam discharge—for the exhaust or intake of internal combustion engines, and for air compressor intakes.

Write for details.

THE MAXIM SILENCER CO.
92 Homestead Ave. Hartford, Conn.

"It's Real Economy for us to use GULF PARVIS OIL"

...Says this Manager

"With Efficient Lubrication we avoid Shut-downs for Cleaning and Repairs"

"WHEN we installed this new Diesel engine, we knew what type of lubricating oil would be best for it," says this Plant Manager. "Gulf Parvis Oil had helped us keep our old Diesel in top-notch operating condition for many years. So, from the start, this new Diesel has been lubricated with Gulf Parvis Oil as recommended by this Gulf engineer. And we're getting the same economical operation we enjoyed with the old one!"

How can you be sure you are using lubricants which possess the essential qualities modern research and advanced refining methods have made possible today? Here's your safest course: Ask a Gulf engineer to check over your equipment and recommend the proper application of oils and greases exactly suited to each moving part. Then follow his recommendations to the letter. Thus you will get the benefits of the improved characteristics which exhaustive research and modern refining methods have imparted to Gulf's higher quality lubricants. With better lubrication, you insure smoother operation, greater availability, and lower maintenance costs for all your equipment.

Start now to get the benefits of Gulf's higher quality lubricants and fuels. They are quickly available to you through more than 1100 Gulf warehouses in 30 states from Maine to New Mexico.

GULF OIL CORPORATION · GULF REFINING COMPANY

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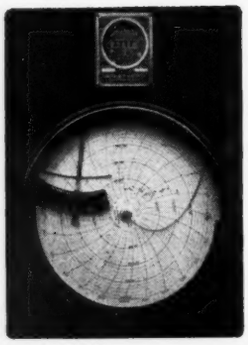
GULF INDUSTRIAL LUBRICATION

ALSO A COMPLETE LINE OF FUEL AND FURNACE OILS

A SYNONYM for—Economy —Accuracy —Efficiency

SIMPLEX



The selection of SIMPLEX meters for your flow measuring problems insures ECONOMIES resulting from low first cost and minimum maintenance and operating charges.

The ability of the SIMPLEX meter to measure with extreme ACCURACY over wide flow ranges insures the obtaining of a definite knowledge of all flow conditions.

Only by the complete instrumentation of all flow functions can true operating EFFICIENCIES be obtained.

There is a SIMPLEX instrument FOR YOUR specific problems.

Let our engineers show you how the proper selection of your metering equipment can insure greater plant ECONOMIES and EFFICIENCIES.

Write for Data

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pressor increased the capacity and efficiency of the unit, according to E R Wolfert, Westinghouse Elec & Mfg Co. Tests on machines of different design and ranging in size from ¾ hp (air cooled) to 20 hp, showed similar results. Discussion emphasized that the conclusion to be drawn from these experiments is that suction gas can be used for motor cooling without loss, but that merely superheating the gas entering the compressor does not produce any true gain unless the heat added to the gas is useful. Thus, a heat exchanger between liquid and suction lines would produce a gain, but simply steam jacketing the suction line to increase the superheat would not.

J G Bergdoll Jr, York Ice Machinery Co, told of tests run along similar lines which checked the Westinghouse results for smaller units. York found, however, that superheating does not improve either capacity or efficiency of larger units, but may cause a reduction, as has been commonly thought. This seems to be due to the difference in the relation between cylinder volume and surface of piston and cylinder.

R A Brodesser, Southern Dairies Inc, described improvements in ice-cream refrigeration, including high-speed multistage compressors, precoolers and multiple headers, improved storage and hardening-room coil arrangement, better truck-body refrigeration, and better cabinet design and construction, which has decreased maintenance and service costs.

Awards Presented at EEI Convention

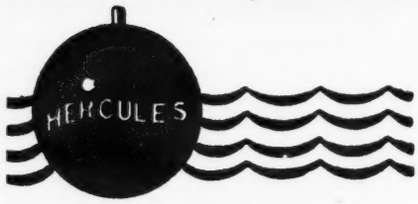
Awarding and presentation of eight groups of awards and prizes was made at the annual convention of the Edison Electric Institute held on June 3 to 6 at Atlantic City, N. J. H P Liversidge, chief executive of the Philadelphia Electric Co, presided at the award ceremonies.

The Charles A Coffin Award, comprising a gold medal and $1000 in cash for the winning company's employees' benefit fund, was awarded the Washington Water Power Co, Spokane, Wash. This award, established in 1922 by the General Electric Co as a tribute to the memory of the late Charles A Coffin, founder of the company, is given annually to "the competing company which has achieved the greatest advancement in its operations and physical plant, thereby making a distinguished contribution to the development of the electric light and power industry for the convenience of the public and the benefit of the industry."

The Washington Water Power Co also won the silver trophy offered by the National Electric Water Heating Council through the Modern Kitchen Bureau for the greatest contribution to the development of the domestic electric water heating load during 1939. A cash award of $1000, accompanying the trophy, goes to individuals in the company responsible for the accomplishment. Honorable mention was awarded the Idaho Power Co, Boise, Idaho; Portland General Electric Co, Portland, Ore.; and the Indiana Service Corp, Fort Wayne, Ind.

The Consolidated Edison Co of New

HERCULES
Seamless Copper
FLOATS



GUARANTEED
TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process, Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

MAKE YOUR
OVERHEAD VALVES SAFE
and EASY TO REACH—
CONTROL VALVES
FROM THE FLOOR

With Babbitt Sprocket Rims on your overhead valves, you can control valves instantly from the floor. Far quicker and safer than climbing ladders.

Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.

BABBITT STEAM
SPECIALTY CO.
New Bedford Mass.

TERRY

Multi-Stage and Single-Stage Steam Turbines For All Mechanical Drive Applications

Terry Turbines are built in all sizes up to 2000 HP and for all commercial steam pressures and exhaust pressures. They are available for condensing, non-condensing, low pressure, mixed pressure and bleeder operation.

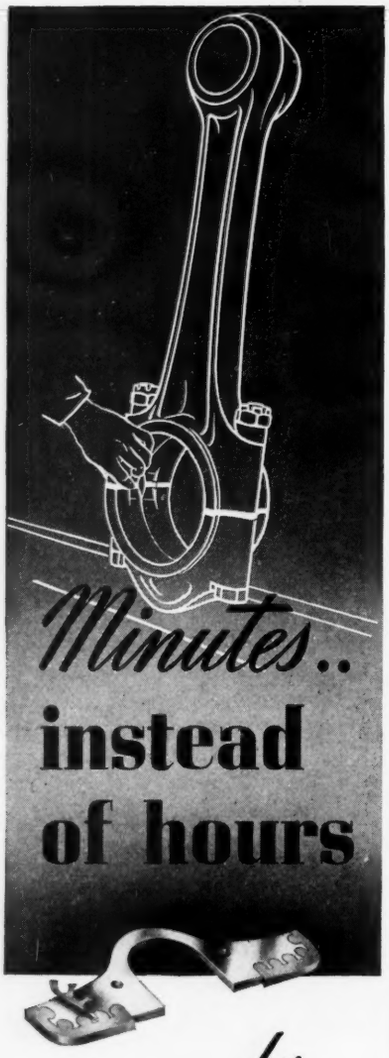
The types include

— Terry Solid Wheel Turbines.
— Single Stage Axial Flow Turbines, using either two or three rows of blading.
— Multi-Stage Impulse Turbines.

Our engineers will be glad to submit data and estimates on the proper type to meet your requirements.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

T-1135



for maintenance

Have your machines spend less down-time for adjustment! Countless hours are saved . . . for production . . . from first assembly to the end of bearings' life . . . by simply peeling adjustments of .002 or .003 inch from the solid laminated brass shims. No filing or costly precision grinding!

• *LAMINUM shims cut to order . . . stock shim materials furnished by mill supply houses.*

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61 Union St., Glenbrook, Conn.

Write for file-folder of shim application photos—with Laminum sample.

LAMINUM
TRADE MARK
THE SOLID SHIM THAT peels FOR ADJUSTMENT
A-1149

York, Inc, received the Augustus D Curtis Award as the public utility company which during the year has shown the greatest contribution to the advancement of artificial illumination of commercial and public buildings in the United States. James J Joy, of Consolidated Edison, was named as the recipient of $300 in cash accompanying the award.

The B C Forbes Prize, a cash award of $250 founded by B C Forbes, editor of *Forbes Magazine*, for the most meritorious paper dealing with the subject of public relations in the electric light and power industry, went to James M Stafford, Jr, Georgia Power Co, Atlanta, Ga. Two honorable mentions, of equal weight, were awarded to C M Turner, Ebasco Services, Inc, New York, and Robert Livingston, Long Island Lighting Co, Mineola, L. I.

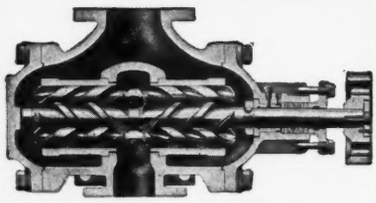
V G Rettig, The Cincinnati Gas and Electric Co, won the first James H McGraw Prize of $250 for the best paper on an engineering or technical subject. His paper was entitled, "Basis for a Program of Capacitor Additions on a Growing Distribution System." Second prize, $150 in cash, was won by Charles L Betts, Jr, Westchester (N. Y.) Lighting Co.

Joseph F Carney Honored By NAPE

Joseph F Carney, Bldg Supt of the Waldorf-Astoria Hotel and past national president of the National Association of Power Engineers, was doubly honored on the evening of May 25 by a testimonial dinner at the Waldorf and by the presentation of the Robert Grimshaw Medal. More than 250 prominent members of the NAPE gathered in the famous Sert Room for the dinner, sponsored by Greater New York Association No. 1.

Presentation of the medal at the end of the proceedings was made by A H Morgan, personal representative of New York's Mayor La Guardia. Ninety-year old Robert Grimshaw, donor of the Grimshaw Medal, and first editor of POWER in 1884, was on hand to greet Mr Carney.

Clyde R Place (right) and the guest of honor chat over the dinner table. Mr. Place was toastmaster at the testimonial banquet given Joseph F Carney



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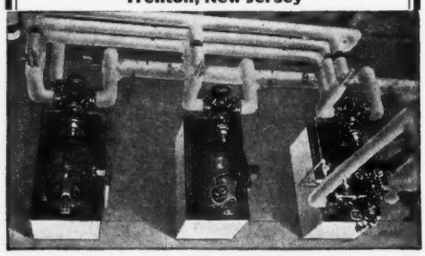
run at MOTOR AND TURBINE SPEEDS

IMO mixers I MOVE OIL

The units shown below supply Bunker C oil at 300 lb. per sq. in. to burners in a New York City office building. Two are driven by motors, one by a steam turbine, all at 1750 r.p.m. IMO pumps handle all kinds of oil.

Ask for Catalog I-59

DE LAVAL STEAM TURBINE CO.
Trenton, New Jersey



YOUR Dependable Guide

. . . to the big things and little things done each month by operators and manufacturers across the country to raise plant efficiencies, cut costs, and reduce trouble.

It Pays You to

Read POWER Regularly

NEW HIGH-PRESSURE boiler recently installed in a large southwestern industrial plant. Both engineers and boiler-makers credited NATIONAL Seamless Boiler Tubes with helping materially to complete a superior installation in fast time, on this job.

...with NATIONAL SEAMLESS TUBES

REPORTS have been coming in from all over the country, telling how NATIONAL Seamless Boiler Tubes, in one boiler after another, have helped complete superior installations in less time than expected.

"What's the secret?" many have asked. "Why do these tubes produce a tighter, more permanent job in less time?"

The answer is simple enough. NATIONAL Seamless Boiler Tubes are 100% annealed. This carefully controlled annealing process produces just the right balance between strength and ductility. And since the tubes are seamless, they withstand all flaring, rolling, and beading operations with no tendency to split or crack. This saves time, prevents waste in labor and materials.

To assure uniformly high wall strength throughout these tubes, they are pierced from highest quality killed open-hearth steel. Subsequent forming operations are closely inspected and tested, to make sure that these tubes, when they reach your plant, are as fine as modern manufacturing methods can make them.

Whether you are building a new high-pressure boiler or retubing an old boiler, you'll find that the safest, strongest tube is the best investment. And that means NATIONAL Seamless Boiler Tubes. Write today for data.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

A Wilson "Matched Unit"—An E P (Extra Power) Heavy Duty Air Motor and an F P T Cutter Head.

GET *BOTH* EXTRA POWER *AND* LOWER AIR COSTS

Laboratory tests of Wilson E P (Extra Power, Heavy Duty Air Motors prove conclusively their *high* power and *low* air consumption. Under actual operating conditions—on the job—the laboratory test records of these motors are fully confirmed.

Wilson E P (Extra Power) Air Motors—especially designed for heavy duty use—develop more power—from 30% to 75% more—and use *less* air—from 25% to 40% less—than ordinary tube cleaning motors of similar size when actually removing excessively hard scale from tubes or pipes. It is *real* economy to buy tube cleaners which give you *both* increased efficiency and reduced operating costs at the same time.

Send for the name of our representative nearest to you or for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.

PIPE AND TUBE CLEANERS EXCLUSIVELY

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Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGEDWEAR RESURFACER. No chopping or chipping required. Merely sweep out spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Costs only 10c to 14c per sq. ft.

Valuable 68-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

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Please send me complete RUGGEDWEAR information . . . details of FREE TRIAL OFFER —no obligation.

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HUNTER *'Airspring'* GREASE CUPS

Drawn-steel, cadmium plated. Never known to rust!

'Shurflo' OIL CUPS

Use them where grit, dust or lint is a problem.

They're STANDARD In Whole Industries!

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LANSDALE, PENNSYLVANIA

Dinner chairman was past national president H W Wilds, assisted by Warren Lewis, Frank Smart and J B Cubberley, all of No. 1. Clyde Place, well-known consulting engineer, was toastmaster. After an address on the European situation by Dr John I Knudsen of Brooklyn Polytechnic Institute, tributes to Mr Carney were presented by Mr Place, Mr Grimshaw, Mr Wilds, Lucius Boomer, president of the Waldorf-Astoria, Leonard Schultze, architect, and Wm Downey (national NAPE Trustee and engineering supervisor of New York Hospital). All pointed to Mr Carney as a man who had reached the top of his profession by his performance on the job, by meeting and overcoming obstacles, by a spirit of cooperation. Mr Boomer said that Mr Carney had been invited to England several years ago to advise on the service arrangements of S S Queen Elizabeth.

In his valedictory, acknowledging the medal, Mr Carney disclaimed any great achievements. Born on New York's East Side, he told of his early days as a mechanic, of working in the historic Pearl St Station, of early joining of the NAPE and of his first connection with Mr Boomer when he became engineer of the Hotel McAlpin in 1912.

OBITUARIES

CHARLES VAN STONE, 77, inventor of the Van Stone joint and for many years a member of the firm of Lumsden and Van Stone, died at Reading, Mass, May 12. He was a native of England and was widely known in the steam-engineering field.

BRIGADIER GENERAL OTTO H FALK, 74, chairman of the board of Allis-Chalmers Mfg Co, a retired National Guard leader, and officer and director of many corporations, died at his home May 21, after a heart attack. General Falk was born in Milwaukee and attended the German-English Academy there, Northwestern College in Watertown, Wis., and was graduated from Allen Military Academy in Chicago, Ill., as a captain. He went to work in

Otto H Falk

his father's foundry and became vice-president of the Falk Corp. Still holding his presidency in the gear corporation, he became receiver of the Allis-Chalmers Mfg Co in 1912, served as president of the reorganized company from 1913 to 1932 and as chairman of the board since 1932.